

Charles Carroll



22102283408

Med
K7559

John H. Balfour

Portobello

SURGICAL ANATOMY

DEAVER

GENERAL ARRANGEMENT OF CONTENTS

VOLUME I.—UPPER EXTREMITY—BACK OF NECK—SHOULDER—TRUNK—
CRANIUM—SCALP—FACE.

VOLUME II.—NECK—MOUTH—PHARYNX—LARYNX—NOSE—ORBIT—EYEBALL—
ORGAN OF HEARING—BRAIN—MALE PERINEUM—FEMALE PERINEUM.

VOLUME III.—ABDOMINAL WALL—ABDOMINAL CAVITY—PELVIC CAVITY—
CHEST—LOWER EXTREMITY.

Chas Baro Lee

SURGICAL ANATOMY

A TREATISE ON HUMAN ANATOMY
IN ITS APPLICATION TO THE PRAC-
TICE OF MEDICINE AND SURGERY

BY

JOHN B. DEEVER, M.D.

SURGEON-IN-CHIEF TO THE GERMAN HOSPITAL, PHILADELPHIA

IN THREE VOLUMES

*ILLUSTRATED BY 499 PLATES, NEARLY ALL DRAWN FOR THIS WORK
FROM ORIGINAL DISSECTIONS*

VOL. III.

ABDOMEN; PELVIC CAVITY; LYMPHATICS OF THE ABDOMEN AND
PELVIS; THORAX; LOWER EXTREMITY



LONDON

REBMAN, LIMITED

129, SHAFTESBURY AVENUE, W. C.

1903

COPYRIGHT, 1902, BY P. BLAKISTON'S SON & Co.

**WM. F. FELL & CO.,
ELECTROTYPERS AND PRINTERS,
1220-24 SANSOM STREET,
PHILADELPHIA.**

WELLCOME INSTITUTE LIBRARY	
Coll.	welMOmec
Call	
No.	

PREFACE TO VOLUME III.

The present volume completes this work, two volumes of which have been issued.

Although the length of time required for its preparation is to be regretted, this has been justified by the complexity of the subjects treated. Dissection, illustration, and description of the thoracic, abdominal, and pelvic cavities present many difficulties not encountered in other parts.

Cadavers wholly suitable for clearly instructive illustrations are not easily obtained, and under favorable conditions perfect dissections are tedious and difficult.

To show in the best manner what it has been desired to illustrate has required much planning and the utmost care in making the first sketches and time in preparing the final drawings.

The increased number of plates and the corresponding enlargement of the text, particularly in this volume, have also added much to the work of preparation.

The book, as originally planned, was to contain two hundred plates. The present work contains nearly five hundred. The text has been subjected to constant revision, and much has been added, especially with reference to surgical procedure. It is believed that the greater thoroughness secured by these additions will add much to the practical value of the work.

In this revision and work of illustration faithful and valued service has been rendered by Dr. R. F. Gerlach and Dr. J. Rex Hobensack.

My thanks are due to Mr. Frederick Koenig and his able assistants, the artists, with whose help I have been enabled to issue these volumes. The work of sketching from dissections and preparing the drawings required a vast amount of patience and intelligent skill, which I believe will be appreciated by all who examine the printed reproductions.

THE AUTHOR.

CONTENTS OF VOLUME III.

	PAGE
THE ABDOMEN, ...	17
SURFACE ANATOMY OF THE ABDOMEN, ...	18
THE ABDOMINAL PARIETES, ...	41
DISSECTION OF THE ABDOMEN, ...	41
Inguinal Canal, ...	80
DISSECTION OF THE ABDOMINAL CAVITY, ...	106
The Liver, ...	157
The Stomach, ...	163
The Spleen, ...	167
The Small Intestine, ...	169
The Large Intestine, ...	171
The Vermiform Appendix, ...	172
The Kidneys, ...	180
The Pancreas, ...	225
THE DIAPHRAGM, ...	298
THE PELVIC CAVITY, ...	309
The Rectum, ...	338
The Bladder, ...	340
The Prostate, ...	348
The Uterus, ...	364
The Vagina, ...	377
The Fallopian Tubes, ...	383
THE LYMPHATICS OF THE ABDOMEN AND PELVIS, ...	392
THE THORAX, ...	396
THE THORACIC WALL, ...	413
THE THORACIC CAVITY, ...	436
The Pleura, ...	440
The Superior Mediastinum, ...	444
The Middle Mediastinum, ...	470
The Heart, ...	479
The Fetal Circulation, ...	495
The Lungs, ...	501
The Posterior Mediastinum, ...	513
LOWER EXTREMITY, ...	530
SURFACE ANATOMY OF THE LOWER EXTREMITY, ...	530
THE FRONT OF THE THIGH, ...	549
Dissection of the Front of the Thigh, ...	549
THE FRONT OF THE LEG AND THE DORSUM OF THE FOOT, ...	601
Dissection of the Front of the Leg, ...	602
Dissection of the Dorsum of the Foot, ...	617
THE BUTTOCKS, ...	619
Dissection of the Buttocks, ...	620
THE POPLITEAL SPACE, ...	646

	PAGE
THE BACK OF THE THIGH, ...	655
Dissection of the Back of the Thigh, ...	655
THE BACK OF THE LEG, ...	660
Dissection of the Back of the Leg, ...	660
THE SOLE OF THE FOOT, ...	680
JOINTS OF THE LOWER EXTREMITY, ...	701
The Hip-joint, ...	701
The Knee-joint, ...	706
The Tibio-fibular Joints, ...	716
The Ankle-joint, ...	717
The Tarsal Articulations, ...	720
The Tarso-metatarsal Articulations, ...	727
The Intermetatarsal Articulations, ...	728
The Metatarso-phalangeal Articulations, ...	729
The Interphalangeal Articulations, ...	729
THE FOOT AS A WHOLE, ...	730
DISLOCATIONS, ...	735
EXCISIONS OF THE LOWER EXTREMITY, ...	739
DEVELOPMENT OF THE BONES OF THE LOWER EXTREMITY, ...	746
FRACTURES, ...	750
AMPUTATIONS, ...	757
LIGATIONS OF THE ARTERIES, ...	774
NERVE-STRETCHING, ...	788
INDEX, ...	793

LIST OF ILLUSTRATIONS.

PLATE	PAGE
CCCXXII. Surface Anatomy of Anterior Abdominal Wall, ...	19
CCCXXIII. Lines of Arteries, ...	26
CCCXXIV. Diagram of Abdominal Viscera and Lungs,—Anterior View, ...	30
CCCXXV. Diagram of Abdominal Viscera and Lungs,—Posterior View, ...	31
CCCXXVI. Diagram of Abdominal Viscera and Lungs,—Right Side, ...	34
CCCXXVII. Diagram of Abdominal Viscera and Lungs,—Left Side, ...	35
CCCXXVIII. Incisions for Dissection, ...	40
CCCXXIX. Superficial Fascia of the Abdomen and Superficial Vessels, ...	44
CCCXXX. Deep Fascia, Cutaneous Nerves, External Oblique Muscle and Its Aponeurosis, ...	47
CCCXXXI. External Oblique and Latissimus Dorsi Muscles, and Triangle of Petit, ...	51
CCCXXXII. External Abdominal Ring, Intercolumnar Fascia, Spermatic Cord, and Ilio- inguinal Nerve, ...	54
CCCXXXIII. Poupart's and Gimbernat's Ligaments, ...	57
CCCXXXIV. Transverse Sections of Abdominal Wall and Sheath of Rectus Abdominis Muscle, ...	61
CCCXXXV. Internal Oblique Muscle, ...	64
CCCXXXVI. Diagram of a Lower Intercostal Nerve, ...	67
CCCXXXVII. Lower Intercostal Nerves, Transversalis and Rectus Abdominis Muscles, ...	70
CCCXXXVIII. Transversalis Muscle and Sheath of Rectus Abdominis Muscle, ...	74
CCCXXXIX. Epigastric and Deep Circumflex Iliac Arteries, ...	77
CCCXL. Inguinal Canal, Cremaster Muscle, Spermatic Cord, and Ilio-inguinal Nerve, ...	81
CCCXLI. Inguinal Canal, Conjoined Tendon, and Triangular Ligament, ...	84
CCCXLII. Inguinal Canal, Conjoined Tendon, Infundibuliform Fascia, ...	85
CCCXLIII. Inguinal Canal, Poupart's Ligament, Spermatic Cord, and Cremaster Muscle, ...	88
CCCXLIV. Diagrams of the Varieties of Congenital Hernia, ...	92
CCCXLV. An Acquired Oblique Inguinal Hernia, ...	95
CCCXLVI. Inguinal Fossæ, ...	107
CCCXLVII. Diagram of Abdominal Viscera and Lungs,—Anterior View, ...	113
CCCXLVIII. Peritoneum Traced Vertically in the Fetus and the Adult, ...	118
CCCXLIX. Peritoneum Traced at the Level of the Foramen of Winslow, ...	121
CCCL. Peritoneum Traced Above the Level of the Transverse Colon, ...	124
CCCLI. Peritoneum Traced Below the Level of the Transverse Colon, ...	125
CCCLII. Abdominal Viscera and Great Omentum, ...	133
CCCLIII. Right Side of Mesentery, Cecum, and Ascending Colon, ...	138
CCCLIV. Left Side of Mesentery, and Descending Colon, ...	139
CCCLV. Attachments of Mesentery and Mesocolon, ...	143
CCCLVI. Duodeno-jejunal Fossa, ...	148
CCCLVII. Ileo-colic Fossa, ...	151
CCCLVIII. Ileo-cecal Fossa, ...	154
CCCLIX. Subcecal Fossa, ...	155
CCCLX. Superior Surface of Liver, ...	160
CCCLXI. Inferior Surface of Liver, ...	161
CCCLXII. Diagram of Positions of the Vermiform Appendix, ...	174

LIST OF ILLUSTRATIONS.

PLATE	PAGE
CCCLXIII. Structures in Great Omentum and Lesser Omentum, ...	183
CCCLXIV. Vasa Brevia,—Structures in Gastro-splenic Omentum, ...	188
CCCLXV. Structures Behind the Posterior Parietal Layer of Peritoneum,—the Lesser Omentum, ...	191
CCCLXVI. Superior Mesenteric Vessels, ...	194
CCCLXVII. Inferior Mesenteric Vessels, ...	198
CCCLXVIII. Internal Surface of Small Intestine Showing Valvulæ Conniventes, ...	201
CCCLXIX. Internal Surface of Ileum Showing Peyer's Patches, ...	204
CCCLXX. Ileo-cecal Valve,—External View, ...	211
CCCLXXI. Section through the Ileo-cecal Valve, ...	214
CCCLXXII. Ileo-cecal Valve,—Internal View, ...	215
CCCLXXIII. Duodenum and Pancreas, ...	223
CCCLXXIV. Portal Vein, Superior and Inferior Mesenteric Veins, and Splenic Vessels, . .	227
CCCLXXV. Inferior Surface of Liver, ...	231
CCCLXXVI. Superior Surface of Liver, ...	235
CCCLXXVII. Pancreatic and Common Bile-ducts, ...	239
CCCLXXVIII. Pancreas and Duodenum, with Pancreatic and Common Bile-ducts, ...	242
CCCLXXIX. The Stomach and Its Arteries, ...	245
CCCLXXX. Incision and Sutured Wound in Pyloroplasty, ...	249
CCCLXXXI. Abdominal Aorta, Inferior Vena Cava, Kidneys, and Ureters in Situ, ...	254
CCCLXXXII. Kidney, Renal Vessels, and Ureter, ...	257
CCCLXXXIII. Sections of Kidney, ...	259
CCCLXXXIV. Types of Sinus of Kidney, ...	263
CCCLXXXV. Kidney, Renal Vessels, and Ureters, ...	267
CCCLXXXVI. Stomach, Liver, Pancreas, Celiac Axis, Hepatic, Pyloric, and Gastric Arteries, and Portal Vein, ...	271
CCCLXXXVII. The External Surface of the Spleen, ...	274
CCCLXXXVIII. The Internal Surface of the Spleen, ...	275
CCCLXXXIX. Abdominal Aorta, Inferior Vena Cava, Kidneys and Ureters in Situ, ...	281
CCCXC. Cervical and Thoracic Sympathetic Nerves, ...	286
CCCXCI. Abdominal Sympathetic Nerves, ...	287
CCCXCII. Diagram of the Lumbar and Sacral Plexuses, ...	291
CCCXCIII. The Lumbar Plexus, ...	295
CCCXCIV. The Diaphragm, ...	299
CCCXCV. Quadratus Lumborum, Psoas, and Iliacus Muscles, ...	305
CCCXCVI. Pelvic Cavity of Male—Superior View, ...	312
CCCXCVII. Pelvic Cavity of Female—Superior View, ...	315
CCCXCVIII. Diagram of Pelvic Fascia, ...	319
CCCXCIX. Internal Iliac Artery and its Branches, ...	322
CCCC. Ligation of External Iliac Artery, ...	325
CCCCI. Uterus, Broad Ligament, Uterine Artery, and Ureter, ...	331
CCCCII. Male Pelvis and Perineum—Sagittal Section, ...	341
CCCCIII. Bladder, Prostate, Seminal Vesicles, Vasa Deferentia, ...	349
CCCCIV. Sympathetic Plexus, ...	355
CCCCV. Diagram of Lumbar Plexus, ...	359
CCCCVI. Diagram of Sacral Plexus, ...	362
CCCCVII. Sections of Uterus and Vagina, ...	365
CCCCVIII. Uterus, Broad Ligament, Uterine Artery, and Ureter, ...	373
CCCCIX. Pelvic Cavity of Female—Superior View, ...	381
CCCCX. Ligation of External Iliac Artery, ...	387
CCCCXI. Muscles in Floor of Pelvis—Superior View, ...	390
CCCCXII. Ligation of Internal Mammary Artery, ...	401
CCCCXIII. Diagram of Position of Heart and Location of Cardiac Valves, ...	405
CCCCXIV. Points for Aspiration of Pleura and Pericardium, ...	408
CCCCXV. Position of the Heart and Lungs, ...	411

PLATE	PAGE
CCCCXVI. The Intercostal Muscles, ...	418
CCCCXVII. Anterior Mediastinum, ...	421
CCCCXVIII. Epigastric and Deep Circumflex Iliac Arteries, ...	424
CCCCXIX. Diagram of Upper Intercostal Nerve, ...	432
CCCCXX. Diagram of a Lower Intercostal Nerve, ...	433
CCCCXXI. Anterior Mediastinum, ...	438
CCCCXXII. Structures in the Superior Mediastinum, and the Pericardium and Roots of the Lungs, ...	445
CCCCXXIII. Structures in the Superior Mediastinum, and the Heart and Lungs, ...	453
CCCCXXIV. Cross-section of the Thorax through the Superior Mediastinum, ...	461
CCCCXXV. Posterior Mediastinum, View of Trachea, Bronchi, Lungs, and Heart from Behind, ...	465
CCCCXXVI. Cross-sections of the Thorax, ...	471
CCCCXXVII. Pericardium and Roots of the Lungs, ...	475
CCCCXXVIII. Anterior View of the Heart and Its Vessels, ...	477
CCCCXXIX. Posterior View of the Heart and Its Vessels, ...	481
CCCCXXX. Right Auricle and Ventricle, ...	485
CCCCXXXI. Left Auricle and Ventricle, ...	490
CCCCXXXII. Aortic Semilunar Valves, ...	493
CCCCXXXIII. Anterior View of Trachea and Lungs, ...	498
CCCCXXXIV. Posterior View of Trachea and Lungs, ...	499
CCCCXXXV. Diagram of Lungs—Anterior View, ...	504
CCCCXXXVI. Diagram of Lungs—Posterior View, ...	505
CCCCXXXVII. Mediastinal Surface of Right Lung, ...	510
CCCCXXXVIII. Mediastinal Surface of Left Lung, ...	511
CCCCXXXIX. The Posterior Mediastinum, Viewed from the Front, ...	516
CCCCXL. The Posterior Mediastinum, Viewed from the Right Side, ...	520
CCCCXLI. The Posterior Mediastinum, Viewed from the Left Side, ...	521
CCCCXLII. The Venæ Azygos, Thoracic Duct, Intercostal Vessels and Nerves, ...	525
CCCCXLIII. Surface Markings of Anterior Aspect of Lower Extremity, ...	531
CCCCXLIV. Bryant and Nelaton's Lines, ...	534
CCCCXLV. Surface Markings of Outer Aspect of Lower Extremity, ...	537
CCCCXLVI. Surface Markings of Posterior Aspect of Lower Extremity, ...	540
CCCCXLVII. Surface Markings of Internal Aspect of Lower Extremity, ...	543
CCCCXLVIII. Abdomen,—Deep Layer of Superficial Fascia, Superficial Epigastric, and Circumflex Iliac Vessels, ...	551
CCCCXLIX. Lines for Incisions in Dissection, ...	554
CCCCL. Subcutaneous Vessels and Nerves of Front of Thigh, ...	557
CCCCLI. Intermuscular Septa, ...	561
CCCCLII. Saphenous Opening, Femoral Canal, and Compartments of Femoral Sheath, ...	567
CCCCLIII. Diagram of Hunter's Canal, ...	573
CCCCLIV. Hunter's Canal and Contained Structures, ...	576
CCCCLV. Muscles, Vessels, and Nerves of Front of Thigh, ...	579
CCCCLVI. Profunda Femoris Artery and Obturator Nerve, ...	583
CCCCLVII. Muscles, Vessels, and Nerves of Front of Thigh, ...	590
CCCCLVIII. Adductor Muscles, ...	595
CCCCLIX. Cutaneous Vessels and Nerves of Front of Leg, ...	603
CCCCLX. Extensors of Digits and Peroneal Muscles, ...	609
CCCCLXI. Anterior Tibial Artery and Nerve, Dorsalis Pedis Artery and Musculo-cutaneous Nerve, ...	613
CCCCLXII. Cutaneous Vessels and Nerves of the Back of the Lower Extremity, ...	621
CCCCLXIII. Gluteus Maximus and Flexor Muscles of the Knee, ...	625
CCCCLXIV. Ligation of Gluteal and Internal Pudic Arteries at Their Points of Exit, ...	630
CCCCLXV. Gluteal Region with Gluteus Maximus Muscle Reflected, ...	631
CCCCLXVI. Gluteus Minimus, Superior Gluteal Artery and Nerves, Obturator Externus, ...	635

PLATE	PAGE
CCCCLXVII. Great Sciatic Nerve, ...	639
CCCCLXVIII. Ligation of Sciatic Artery at Its Point of Exit and of Internal Pudic Artery, ...	643
CCCCLXIX. Popliteal Space, ...	649
CCCCLXX. Muscles of Buttock and Flexor Muscles of the Knee, ...	657
CCCCLXXI. Cutaneous Vessel and Nerves, Back of Leg, ...	661
CCCCLXXII. Gastrocnemius Muscle, ...	665
CCCCLXXIII. Soleus and Plantaris Muscle, ...	668
CCCCLXXIV. Deep Transverse Fascia, ...	672
CCCCLXXV. Peroneal Artery, ...	673
CCCCLXXVI. Deep Muscles of the Back of the Leg and Posterior Tibial Artery and Nerve, ...	677
CCCCLXXVII. Deep Plantar Fascia, ...	681
CCCCLXXVIII. First Layer of Muscles of the Sole of the Foot, ...	685
CCCCLXXIX. Second Layer of Muscles of the Sole of the Foot, Plantar Vessels and Nerves, ...	691
CCCCLXXX. Third Layer of Muscles of the Sole of the Foot, ...	695
CCCCLXXXI. Fourth Layer of Muscles of the Sole of the Foot, Plantar Arch, and Deep Branch of the External Plantar Nerve, ...	699
CCCCLXXXII. Anterior View and Longitudinal Section of the Hip-joint, ...	703
CCCCLXXXIII. Anterior View and Longitudinal Section of the Knee-joint, ...	707
CCCCLXXXIV. Posterior View of the Knee-joint, ...	711
CCCCLXXXV. Ligaments of Tarsus—External and Internal View, ...	721
CCCCLXXXVI. (A) Ligaments of the Foot, Plantar Surface. (B) Section Showing the Synovial Cavities of the Foot, ...	725
CCCCLXXXVII. Lines of Excisions, ...	741
CCCCLXXXVIII. Lines of Excisions, ...	743
CCCCLXXXIX. Lines of Excisions, ...	747
CCCCXC. Fractures of the Shaft of the Femur, ...	751
CCCCXCI. (A) Fracture of Both Bones of the Leg. (B) Fracture of Both Malleoli;	755
CCCCXCII. Amputation of Leg, Upper Third, ...	765
CCCCXCIII. Amputation at the Upper Third of the Thigh, ...	770
CCCCXCIV. Amputation at the Lower Third of the Thigh, ...	771
CCCCXCV. Lines of Incisions for Ligations and Nerve Stretching, ...	776
CCCCXCVI. Ligation of Femoral Artery in Scarpa's Triangle and in Hunter's Canal, ...	777
CCCCXCVII. Ligation of the Posterior Tibial Artery in the Upper, Middle, and Lower Third of the Leg, ...	781
CCCCXCVIII. Ligation of the Anterior Tibial Artery in the Upper, Middle and Lower Third of the Leg, ...	785
CCCCXCIX. Lines of Incisions for Ligation of Arteries and Nerve Stretching, ...	789

SURGICAL ANATOMY.

THE ABDOMEN.

The abdomen includes the general abdominal cavity, its contents, and its boundaries.

The superficial boundaries of the abdomen are the lower margin of the chest above, the crests of the ilia, the creases of the groins, and the crests of the pubic bones below, and the external margins of the erector spinæ muscles laterally.

The deep boundaries of the abdomen are those of the general abdominal cavity.

Form of the Abdomen.—The abdomen varies in form and extent in different individuals, in the two sexes, at different times of life, and as the result of pregnancy and pathologic conditions.

In the infant it is somewhat conic, being wider above than below; the upper part of the abdomen is larger in infancy, on account of the relatively greater size of the liver and small size of the pelvis. The relatively great length of the transverse diameters and the prominence of the abdomen in the infant are produced by the comparatively large liver and the presence in the abdomen of the bladder and the lower part of the sigmoid flexure, which are found in the pelvis in the adult.

In the female adult the abdomen is wider below than in the male, because of the greater width of the pelvis in that sex; it is also longer, on account of the greater length of the lumbar portion of the spinal column in the female. The lower portion of the thorax is narrower; the lower portion of the anterior abdominal wall is more prominent, and the greater amount of subcutaneous fat causes the general outlines to be more rounded than in the male; the greater obliquity of the female pelvis also leads to the greater prominence of the lower part of the anterior wall of the abdomen in this sex.

In the male adult a transverse section of the abdomen is oval and flattened antero-posteriorly; in muscular individuals the positions of the linea alba, lineæ

semilunares, and lineæ transversæ are indicated by slight depressions of the surface with intervening prominences.

In pathologic conditions the form of the abdomen is more or less characteristic; for instance, in ascites there is bulging in the flanks, and the abdomen is rather flat and is symmetric; in tympanites the abdomen is uniformly distended and is rounded; an ovarian cyst causes the abdomen to be rather conic and to bulge anteriorly; in chronic diseases associated with great emaciation it is hollowed out anteriorly or is scaphoid.

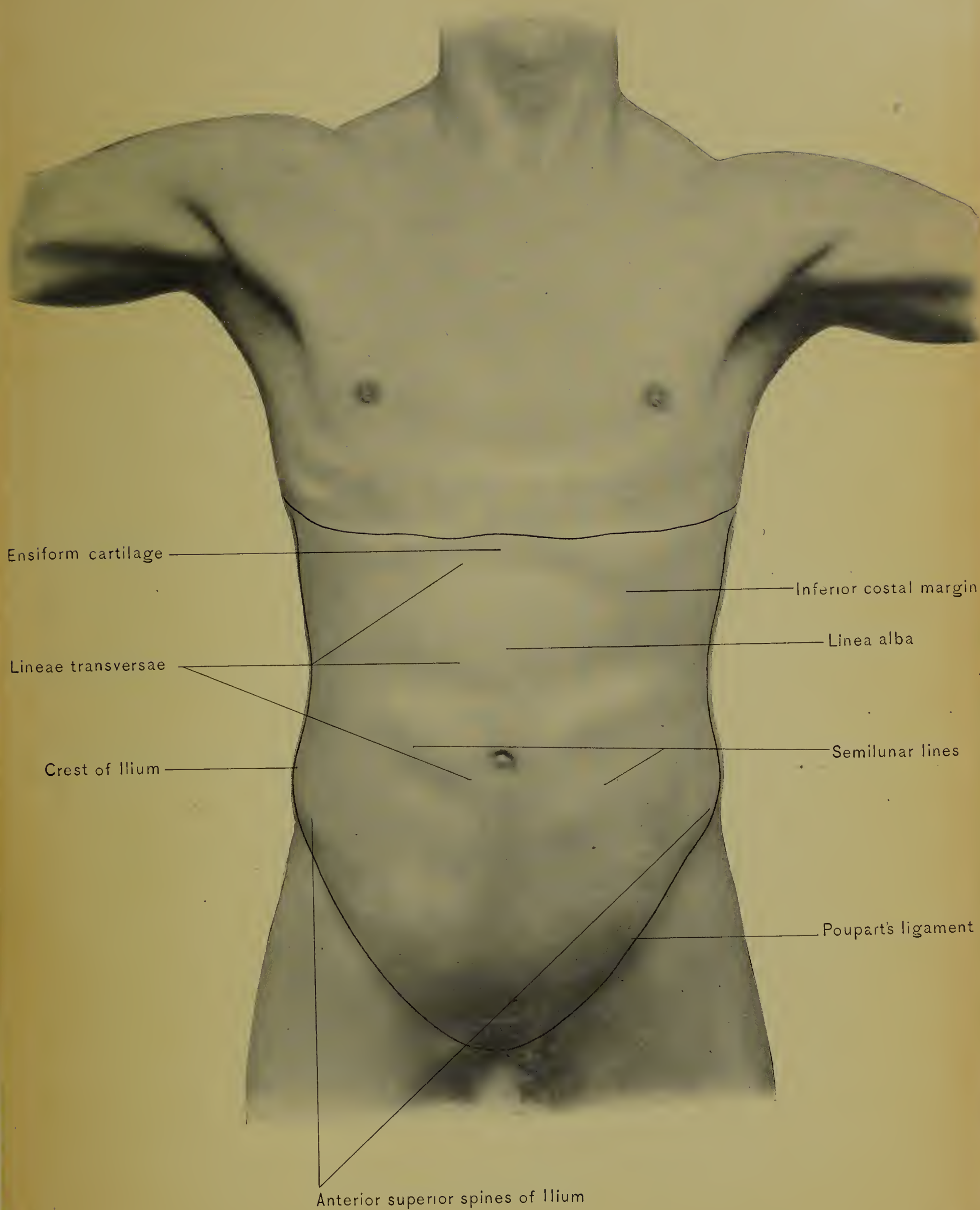
A **pendulous** or **prominent abdomen** in the adult is caused by excess of fat in the superficial fascia, which is thickest at the lower part of the abdomen, and by relaxation of the belly-wall from stretching produced by pregnancy, ascites, or tumors.

The ease with which **abdominal palpation** can satisfactorily be practised depends upon the amount of subcutaneous fat and the degree of relaxation of the abdominal wall. In women who have borne a number of children and who have but a small amount of adipose tissue in the superficial fascia the wall of the abdomen is usually lax, and in such cases even small tumors can be detected; whereas in a muscular adult, with considerable adipose tissue, palpation is rendered very difficult and oftentimes unsatisfactory.

SURFACE ANATOMY.

The **Skin** covering the front of the abdomen is, in most locations, loosely attached, and especially in the regions of the groins; it is more adherent to the subjacent aponeurosis at the lineæ transversæ and linea alba, but it is not so adherent at the linea alba as to hinder the spread of subcutaneous inflammation from one side of the abdominal wall to the other. In both sexes the skin over the bodies of the pubic bones and for some distance above is covered with hair. The skin of the lower part of the abdomen is often found to contain scar-like white lines—**Lineæ Albicantes**. These are due to atrophy of the skin, produced by stretching, and most commonly result from pregnancy, but may also be produced by distention from ascites or from ovarian or other large tumors.

The **Linea Alba**, the median line of the abdomen, extends from the ensiform cartilage to the symphysis pubis, and is the thinnest part of the abdominal wall, because no muscular tissue is found in that line. Like the median line of the trunk elsewhere, it is the least vascular part of the abdominal wall; and hence has been preferred for incision in abdominal operations. In most cases the author prefers to operate through one of the rectus muscles or the flat muscles of the abdominal wall, as hernia is less likely to occur in a cicatrix



SURFACE ANATOMY OF ANTERIOR ABDOMINAL WALL.

including muscle and fascia than in one including only fascia or aponeurosis. Through the linea alba the abdomen is tapped in ascites, and the bladder is aspirated or opened in the supra-pubic operation.

Above the umbilicus the course of the linea alba is indicated by a groove situated between two ridges formed by the rectus muscles, but below the umbilicus there is no depression marking the location of that line.

Behind the Linea Alba, throughout its length, the peritoneum is in contact with the anterior abdominal wall, except at its lower three-fourths to one and one-half inches (two to four centimeters), where the summit of the bladder intervenes. We find the left lobe of the liver extending across the upper one and one-half to two inches (four to five centimeters) of the line. Below the liver is the stomach, which has a very extensive contact with the abdominal wall when distended, but which is retracted or shrunk up behind the liver and left chest when empty. It is when the latter condition is present that the upper part of the abdomen in the median line is sunken, and called the **Pit of the Stomach**. Below the stomach, but still above the umbilicus, is the transverse colon, which occupies a varying space, depending upon the amount of gas and fecal matter it contains. Below the umbilicus the small intestine, covered by the great omentum, lies behind the median line, down to the crests of the pubic bones, except in the latter half of pregnancy and when the bladder is full of urine. When the bladder is distended, it carries the peritoneum upward and lies behind the lower two inches (five centimeters) of the linea alba, and may extend upward as far as the umbilicus.

The **Lineæ Semilunares**, one on each side of the linea alba, extend along the outer margins of the rectus abdominis muscles with a slight outward curve, from the tip of the cartilage of the ninth rib to the inner side of the spine of the pubis. The lineæ semilunares in the upper three-fourths of the abdomen are about three inches, or seven centimeters, from the linea alba in the adult. Near the crest of the pubis this distance is not so great.

The **Lineæ Transversæ** are caused by the adherence of the anterior wall of the sheath of the rectus abdominis muscle to the superficial fascia and the tendinous intersections of the rectus abdominis muscles, and extend between the linea alba and the lineæ semilunares. There are usually three on each side, the lowest being at the level of the umbilicus, the highest at the ensiform cartilage, and the middle one about midway between the other two; sometimes there is one below the umbilicus. During contraction the rectus muscle forms elevations between these lines, which are more pronounced in muscular individuals. These elevations are plainly seen when the individual leans the trunk backward and extends both arms above the head, thus necessitating strong contraction of the rectus abdominis muscles.

The **Umbilicus** is a depressed cicatrix situated slightly below the middle of the linea alba, but above the middle of the height of the body in the adult and below the middle of the height of the body in the young child. Its position varies slightly with the degree of pendency of the abdominal wall. It is opposite the third lumbar vertebra, or the disc between the third and the fourth lumbar vertebra. In the fetus it is patulous, and gives passage to the vitelline duct and vessels, the allantoic duct, the two hypogastric arteries, and the umbilical vein. After separation of the umbilical cord after birth it is closed. A hernia frequently protrudes at the umbilicus.

After separation of the stump of the umbilical cord there may be an **umbilical fistula** from which feces or urine escapes. The feces escape through a persistent vitello-intestinal duct which should have been obliterated. The vitello-intestinal duct connects the yolk sac with the alimentary canal of the young embryo, and may persist as a canal or cord extending from the lower part of the ileum to the umbilicus. An umbilical urinary fistula is produced by persistence of the canal in the urachus, which is derived from the allantois.

As the result of failure of union between the lateral halves of the abdominal wall at the median line there occurs a defect, known as **exstrophy of the bladder**, from the fact that the bladder-wall protrudes through the abnormal opening. In these cases the anterior wall of the bladder is also absent, and the posterior wall of that organ is the one which is seen; furthermore, there is frequently associated with this condition a defective junction of the two halves of the pelvis at the symphysis pubis. The penis may be rudimentary, and the urethra open on the dorsum of that organ; the latter abnormality is known as **epispadias**.

In very stout persons the abdominal wall contains a deep **Transverse Crease** which includes and hides the umbilicus, and another just above the fat of the mons veneris; it is through the intersection of the latter crease with the linea alba that the trocar is passed to tap the bladder.

The **Limits of the Anterior and Lateral Abdominal Wall** are the lower border of the thorax, the outer margins of the quadratus lumborum muscles, the crests and anterior superior spines of the ilia, Poupart's ligament, and the spines, crests, and symphysis of the pubic bones.

The **Ensiform Cartilage** lies in the angle of the infra-sternal or interchondral space. It is irregular in size, shape, and direction: it may be broad and flaring, narrow and pointed, long or short, bifid or perforated; it may curve forward or laterally, or may incline backward and cause pain by pressure upon subjacent structures.

The **Interchondral Space, Subchondral or Subcostal Angle**, is formed by the divergence of the anterior portions of the lower margins of the thorax, and varies

considerably in different individuals, from the wide flaring angle of the professional runner to the long narrow angle of the "pigeon-breast." It is artificially narrowed to a considerable extent in women who wear corsets. When this angle is almost or more than a right angle and its margins are freely movable, respiration is deep and complete; whereas a small subcostal angle is associated with contracted chest, which is considered a predisposing cause of chronic pulmonary disease.

The **Anterior Superior Iliac Spines** are readily located in the stoutest individuals. They are valuable landmarks in the diagnosis of disease of the abdomen, pelvis, hip, and lower extremity, because of their fixity and ease of identification. They are used in estimating the size of the pelvis. They are guides in some abdominal operations, and in ligating the iliac and femoral arteries. From them the length of the lower limbs can be measured.

The anterior parts of the crests of the ilia are grasped to test for crepitus and unnatural mobility in fracture of the pelvis. A line drawn through the highest points of the crests of the ilia passes about three-fourths of an inch (two centimeters) below the umbilicus and about one and one-half inches (four centimeters) below the lower extremities of the kidneys. This line also passes through the spinous process of the fourth lumbar vertebra.

The **Spine of the Pubis** is a valuable landmark in the differential diagnosis of femoral and inguinal herniæ. The guide to it is the adductor longus muscle. Abduction of the thigh increases the tension of the tendon of origin of the adductor longus, which is attached to the body of the pubis just below and internal to the spine, and will guide the finger to the spine. The spine of the pubis is a guide to the external abdominal ring, which is most readily found by invaginating the scrotum with the finger and carrying it upward under the superficial fat. In the differential diagnosis between inguinal and femoral herniæ the spine of the pubis should be located; if the neck of the hernia lie above and internal to the spine of the pubis, it is an inguinal hernia; but if below and external to the spine of the pubis, it is a femoral hernia.

The **Crease of the Groin** extends from the anterior superior spine of the ilium toward the spine of the pubis, and is continuous with the crease between the thigh and the scrotum or labium majus. It is produced by the attachment of the deep layer of the superficial fascia to the fascia lata immediately below Poupart's ligament.

The **External Abdominal Ring** is situated upon the inner side of and above the pubic spine. The opening readily admits the tip of the little finger when introduced by invaginating a fold of the scrotum.

The **Internal Abdominal Ring** is from one-half to three-fourths of an inch

(1.25 to 2 centimeters) above and slightly external to the middle of Poupart's ligament. The abdominal rings are called internal and external, with reference to their proximity to the abdominal cavity and not to the median line, for their relation to the median line of the body is the reverse of the positions which their names imply.

The **Inguinal Canal** is a space within the lower part of the anterior abdominal parietes, above and parallel with the inner half of Poupart's ligament; it transmits the spermatic cord, or round ligament of the uterus, the ilio-inguinal nerve, and the genital branch of the genito-crural nerve. Its direction is downward and inward; its length is from one and one-half to two inches (four to five centimeters). Because of its obliquity, any hernia passing through it is called oblique.

The **Spermatic Cord**, after its exit from the external abdominal ring, is easily identified as a complex, soft, round cord, and the vas deferens is readily felt at its posterior part.

The **Deep Epigastric Artery** runs upward and inward from midway between the anterior superior spine of the ilium and symphysis pubis toward the umbilicus. It passes behind the outer part of the inguinal canal, immediately to the inner side of the internal abdominal ring, and bears an important relation to direct and indirect inguinal herniæ. The direct hernia passes to the inner side of the artery, whereas the indirect hernia, which first traverses the internal ring, passes to the outer side of the artery.

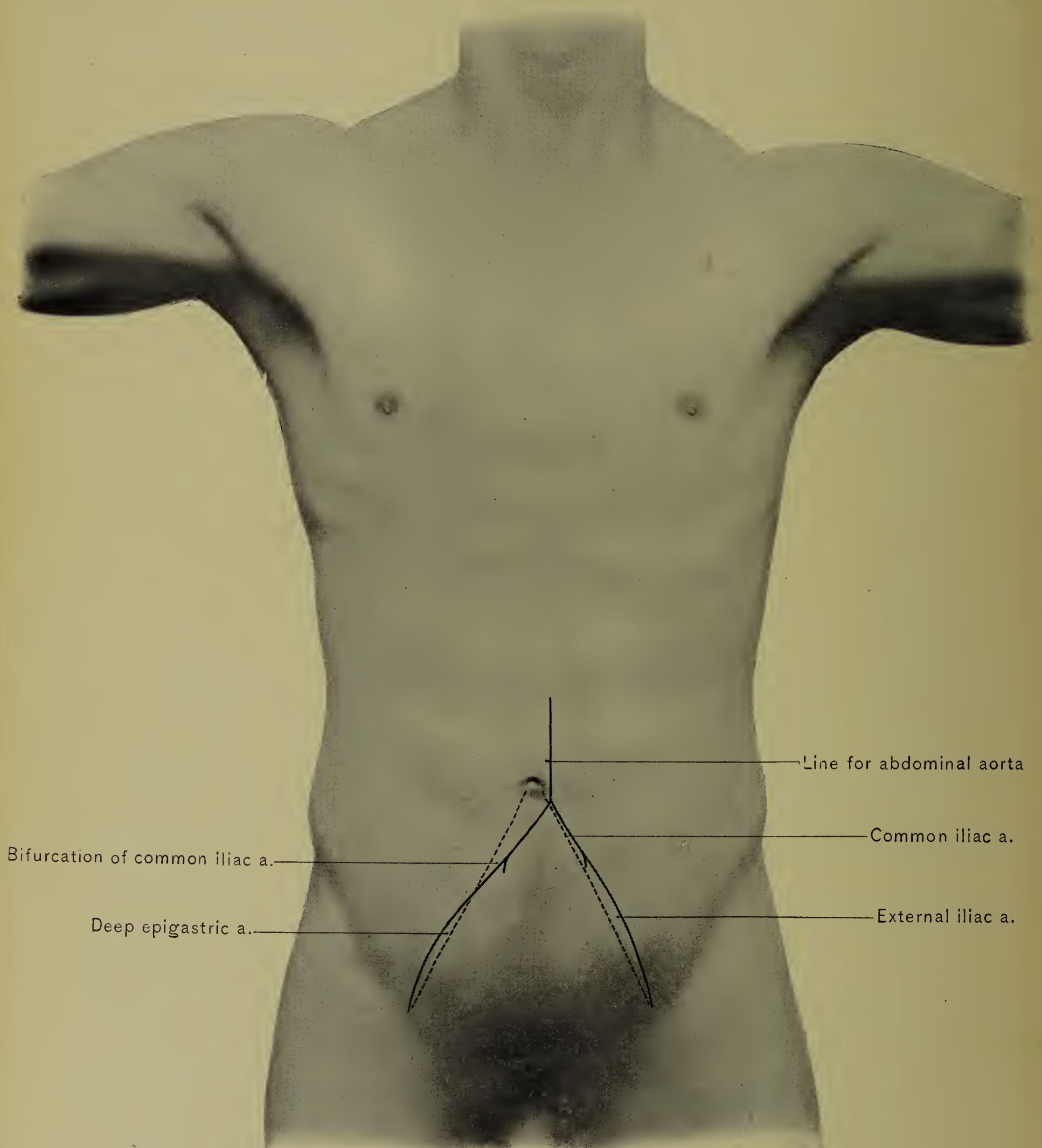
The **Solar Plexus** and the origin of the **Celiac Axis** are from four to five inches (ten to twelve centimeters) above the umbilicus, and opposite the spinous process of the twelfth thoracic vertebra.

The **Superior Mesenteric** and **Suprarenal Arteries** arise immediately below the celiac axis. The **Renal Arteries** arise about a half inch (one centimeter) below the celiac axis, opposite the interval between the spinous process of the twelfth thoracic and that of the first lumbar vertebra.

The **Inferior Mesenteric Artery** arises about an inch (two to three centimeters) above the umbilicus.

Compression of the Abdominal Aorta is best effected by backward pressure applied just below and slightly to the left of the umbilicus, immediately above the division of the aorta into the common iliac arteries. Here it is most superficial, whereas higher up it is covered by important structures, and gives off branches whose current the surgeon does not wish to check, and the thorax would prevent approximation of the anterior abdominal wall to the vertebræ.

The pulsations of the aorta can be felt along the left side of the linea alba, and in thin subjects they are felt so distinctly that the pulsating aorta may be mistaken for an aneurysm or other tumor.



The **Bifurcation of the Aorta** is usually situated three-fourths of an inch (two centimeters) below, and slightly to the left side of, the umbilicus; but as the umbilicus itself varies somewhat in location, a more fixed guide is desirable, so it is preferably stated that the bifurcation of the aorta is opposite a point about one-half inch (one centimeter) to the left of the intersection of the linea alba with a line connecting the highest points of the iliac crests.

The **Line for the Common Iliac Artery and External Iliac Artery** is one slightly curved, with its concavity directed toward the pubic bone, and drawn from the point representing the location of the bifurcation of the aorta to a point midway between the anterior superior spine of the ilium and the symphysis pubis. The first two inches (five centimeters) of this line mark the course of the common iliac artery, and the remainder of the line, that of the external iliac artery. Variations in the length of these two vessels exist, but the relations to the external line remain substantially the same.

The **Locations of the Abdominal Viscera** should be outlined with considerable accuracy in both medical and surgical practice, as success in diagnosis depends largely upon a correct knowledge of the relations of the organs to the abdominal wall. In all examinations of the abdomen the patient should lie upon the back, with the knees raised and the head and shoulders slightly elevated by pillows, so that the muscles of the anterior abdominal wall are relaxed. Palpation should be practised with the palm of the hand flat on the abdomen, and not merely with the finger-tips, as the latter method induces reflex contraction of the muscles which resists manipulation. After manipulation of the parts for a few moments they become less sensitive, and palpation can be more active and more localized and be practised with the finger-tips.

Position of the Diaphragm.—The partition between the abdomen and thorax is formed by the diaphragm. A transverse plane passing backward through the body at the level of the seventh chondro-sternal junction represents the level of the central tendon, which is the highest part of the diaphragm. The attachments of the margins of the diaphragm correspond to a line running along the inferior and lateral margins of the ensiform cartilage, thence from the seventh chondro-sternal junction, along the lower borders of the costal cartilages to the tip of the last rib, and thence to the tip of the transverse process of the first lumbar vertebra, about one inch (2.5 centimeters) from the spinous process of that vertebra.

A knowledge of the line of attachment of the diaphragm is important in connection with operation on the kidney through the loin, as the pleural cavity has been opened during a lumbar nephrolithotomy. A knowledge of the position of the diaphragm is also important in performing paracentesis thoracis, as the aspirating needle might puncture that muscle and enter the peritoneal cavity.

The **Liver** lies in the right hypochondriac, the epigastric, and sometimes extends into the left hypochondriac region as far as the left mammary line. The anterior margin of the right lobe projects about half an inch (one centimeter) below the chondral border, where, during respiration, it can be felt moving upward and downward with the diaphragm, to which it is attached. This border is not so easily recognized as the anterior margin of the left lobe, which extends across the epigastric region, below the ensiform cartilage, and is pushed prominently forward by the stomach when that organ is distended. The liver may extend further downward from various causes, such as the accumulation of fluid or the presence of a tumor above it in the pleural cavity, and by a greatly enlarged heart. The liver ascends as high as the right dome of the diaphragm, within one inch (2.5 centimeters) of the level of the nipple, and to a position opposite the lower end of the gladiolus of the sternum. Therefore below this level, which is that of the fifth intercostal space in the mammary line, hepatic dulness is elicited upon deep percussion over a normal right lung. At the side of the spinal column the liver approaches the surface at the level of the tenth and eleventh thoracic spines, or at the posterior part of the base of the lung.

The liver extends as high as the diaphragm, which conforms to its upper surface. The *outline of the liver*, as marked on the surface of the body, can not be other than approximate, as the organ descends during inspiration and ascends during expiration, and its shape and position may be slightly altered by tightly laced corsets or stays. The liver usually extends only one and one-half inches (four centimeters) beyond the left side of the sternum, or it may reach the left mammary line. It reaches as high as a transverse line drawn through the lower end of the meso-sternum; in the mammary line this transverse line passes over the fifth intercostal space or lower border of the fifth rib. The upper surface of the left lobe of the liver is opposite a transverse line drawn through the lower end of the meso-sternum. The upper surface of the right lobe is opposite the lower border of the fifth rib, in the right mammary line; in the right midaxillary line, opposite the seventh rib; in the midscapular line, opposite the ninth rib; and at the side of the spinal column, opposite the tenth thoracic spinous process. The lower surface of the right lobe posteriorly, or at the side of the spinal column, is opposite the eleventh thoracic spinous process, at the right midaxillary line, opposite the costal margin. Between the midaxillary line and the right linea semilunaris the thin anterior margin of the liver extends about one-half inch (one centimeter) below the costal margin; this margin passes across the epigastrium in a line drawn from the ninth right through the left eighth costal cartilage.

The **Gall-bladder** is almost covered by the liver, but when filled, its fun-

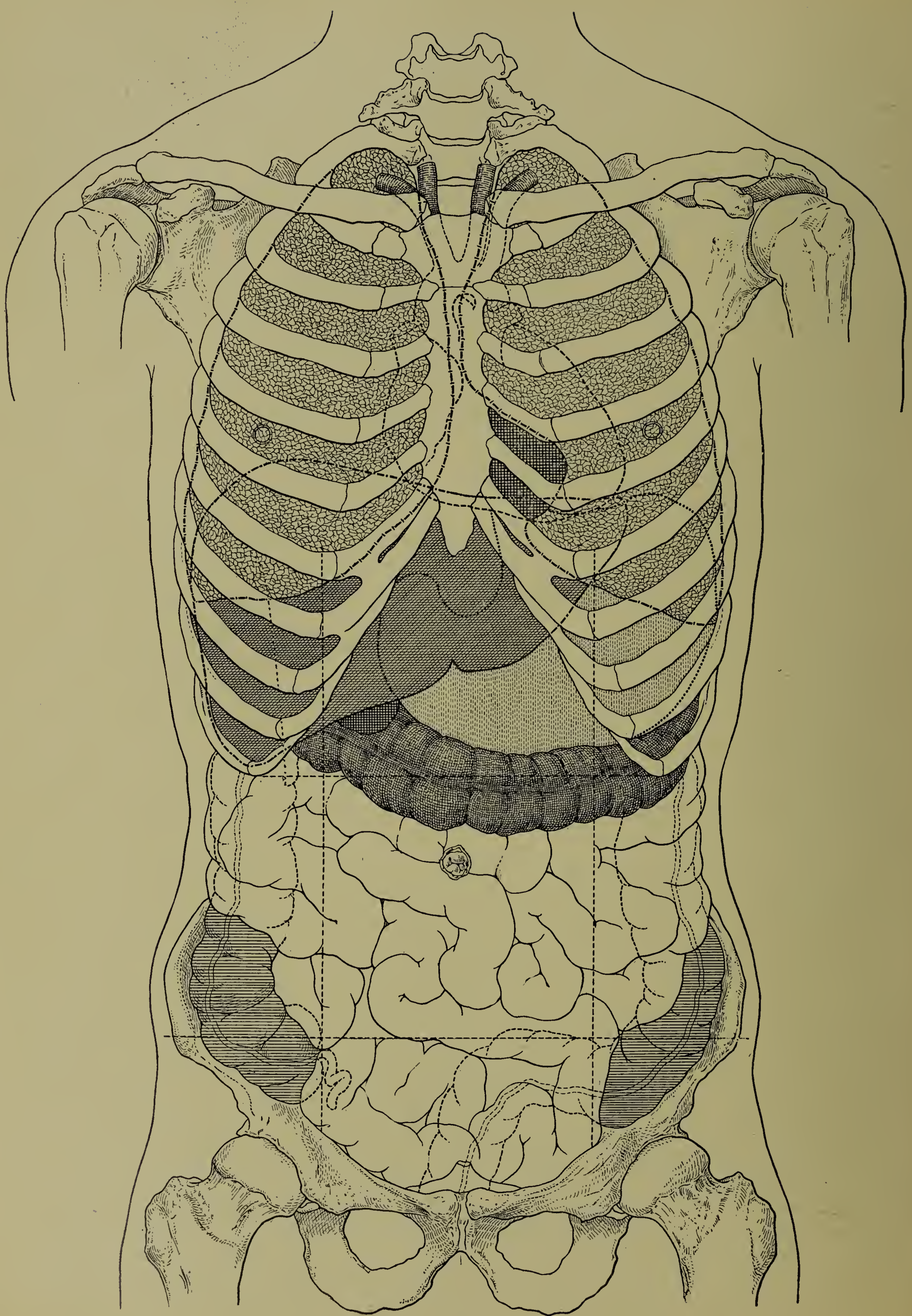


DIAGRAM OF ABDOMINAL VISCERA AND LUNGS,—ANTERIOR VIEW.

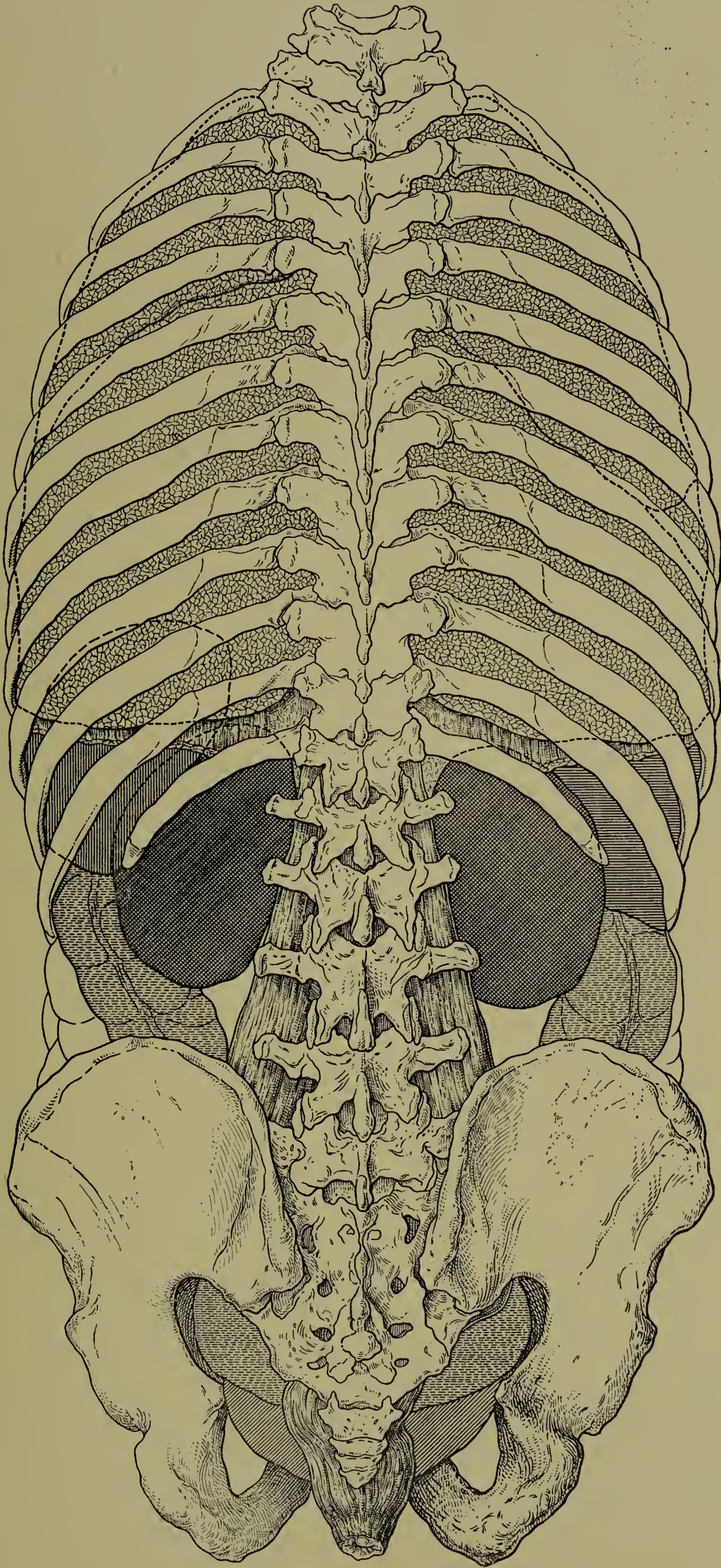


DIAGRAM OF ABDOMINAL VISCERA AND LUNGS,—POSTERIOR VIEW.

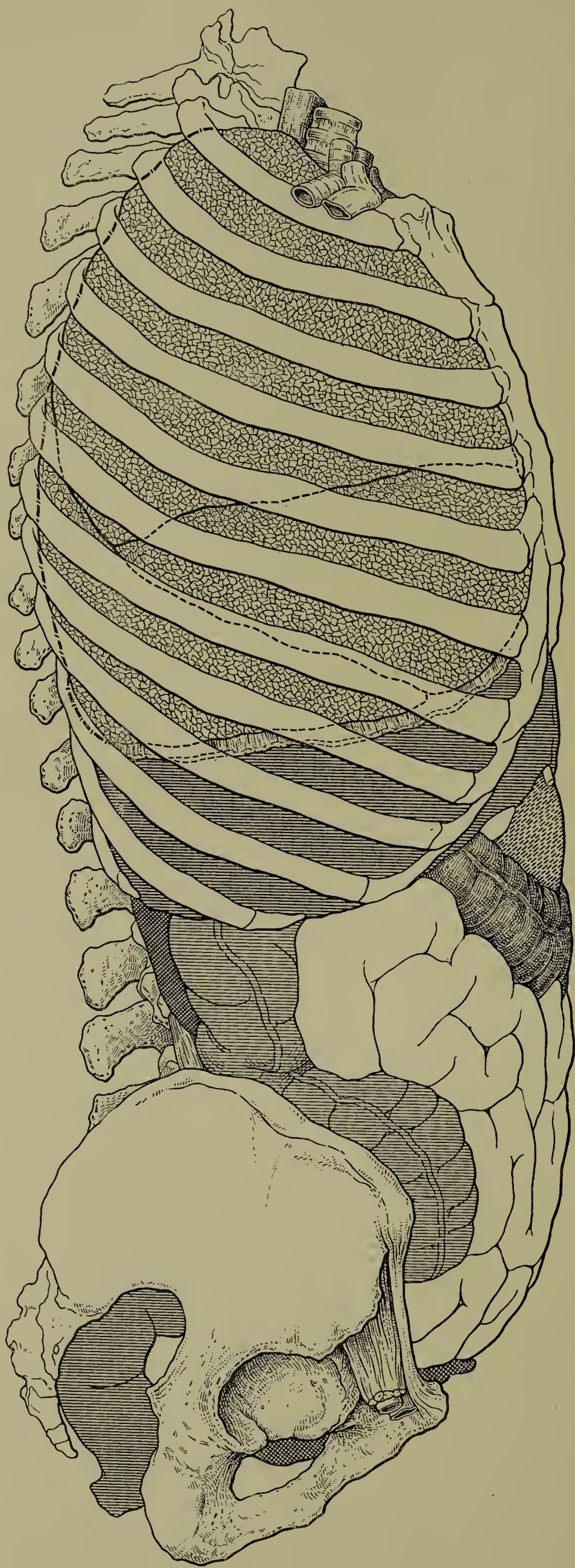


DIAGRAM OF ABDOMINAL VISCERA AND LUNGS,—RIGHT SIDE.

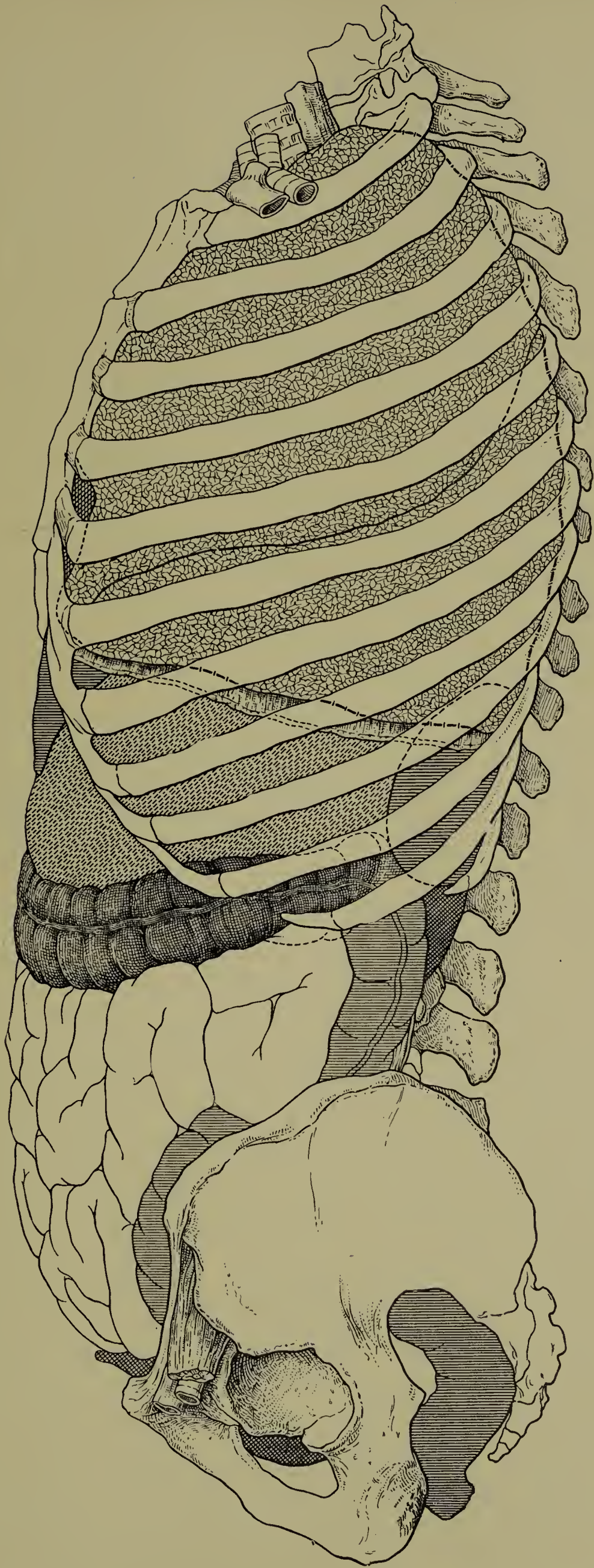


DIAGRAM OF ABDOMINAL VISCERA AND LUNGS,—LEFT SIDE.

dus projects beyond the anterior border of this gland, at the outer margin of the right rectus abdominis muscle, just below the ninth costal cartilage.

The **Stomach** varies in size, being smaller when empty and larger when distended. Therefore its relations are not always the same. The stomach holds an oblique position, lying behind the diaphragm and left chest-wall below the level of the sixth chondro-sternal junction, and behind the anterior abdominal wall and left lobe of the liver. When distended, it is in contact with the anterior abdominal wall in a triangle bounded by the anterior margin of the liver, the left ninth and tenth costal cartilages, and a line drawn between the tenth costal cartilages. It is here that gastrotomy and gastrostomy are performed.

The **cardiac orifice** of the stomach is opposite a point one inch (2.5 centimeters) to the left of the left seventh chondro-sternal junction in front. The **pyloric orifice** lies beneath the liver; when the stomach is empty, it lies about three inches (seven centimeters) below the sterno-xiphoid articulation, slightly to the right of the median line, but as the stomach becomes distended it approaches the right linea semilunaris.

The **line for the lesser curvature** of the stomach is drawn from the position of the cardiac orifice to that of the pyloric orifice. The **line for the greater curvature** extends upward and to the left from the position of the cardiac orifice to the fifth rib, slightly external to the left mammary line, and thence to the position of the pyloric orifice. The line for the lesser curvature is curved toward the outlined area of the stomach, and that for the greater curvature away from that area.

The **Spleen** is in contact with the greater curvature of the stomach at its cardiac end. It is situated internal to the ninth, tenth, and eleventh ribs, from which it is separated by the diaphragm and a wedge-shaped portion of the lung. Its anterior margin is in a line drawn from the left sterno-clavicular articulation to the tip of the eleventh rib. Its extent under the ribs can be estimated by its area of dulness on percussion, and this is most reliably elicited when the stomach is either distended or fully contracted, as either condition forms a background of relatively uniform density. A duller note would be heard over the tenth and eleventh ribs than over the ninth, because of the presence of the lung between the diaphragm and the chest-wall opposite the uppermost part of the spleen. The spleen is enlarged in various diseases, but more commonly in chronic malaria, when it is known as the "ague cake." It may be so enormously enlarged as to reach the crest of the ilium, and may weigh from fifteen to twenty pounds (seven to nine kilograms). Its normal weight is eight ounces (225 grams).

The **Pancreas** crosses the spinal column, inferior vena cava, and aorta behind the stomach, at the first lumbar vertebra. It can be felt only by firm,

deep pressure two or three inches (five to seven centimeters) above the umbilicus, through a thin abdominal wall and empty viscera. It has been mistaken for cancer of the colon or stomach, tumor of the spinal column, or aneurysm of the aorta.

The **Kidney** lies upon the posterior abdominal wall, against the psoas magnus and quadratus lumborum muscles, opposite the spinous processes of the lower two thoracic and upper two lumbar vertebræ, the right kidney being situated slightly nearer the median line, and three-fourths of an inch (two centimeters) lower than the left, to leave space for the liver. The *pelvis of the ureter* is about opposite the spinous process of the first lumbar vertebra. Deep inspiration depresses both kidneys about a half inch (one centimeter), a fact worth remembering in their examination. Though it is difficult to distinguish the kidney under the last rib, at which position, only, it is accessible, its degree of tenderness can readily be determined there. Small growths of the kidney have been detected by palpation of the loin. Care should be exercised so that morbid growths, portions of the spleen or liver, or hardened fecal accumulations in the colon be not mistaken for the kidney. A transverse plane through the umbilicus passes just below the lower border of the kidneys, and they are cut in half by a line drawn vertically upward from the middle of Poupart's ligament. The intersection of these two lines, therefore, marks the middle of the lower end of the kidney. The kidney may be removed through a transverse or a longitudinal incision made in the loin, or through the linea semilunaris. In either of the loin operations the peritoneum is not necessarily opened, but in the latter case the peritoneal cavity is entered.

The **Large Intestine** is divisible into the cecum, colon, and rectum; and the colon, into the ascending, transverse, and descending colon. The colon has three flexures—the hepatic, splenic, and sigmoid.

The **cecum**, with its **vermiform appendix**, lies in the right lumbar region and right iliac fossa. The **ascending colon** extends up the right side of the abdomen, through the right lumbar region, until it reaches the under surface of the right lobe of the liver, where, in the right hypochondriac region, it makes a bend to the left, called the **hepatic flexure**. Next, as the **transverse colon**, it crosses the abdomen, making a downward curve, almost to the umbilicus. The **splenic flexure** lies in the left hypochondrium, in relation with the anterior surface of the spleen, and is the curving downward of the transverse colon to become the **descending colon**, which is narrower and more deeply situated than the ascending colon. The descending colon extends downward through the left lumbar region to the left iliac fossa, where it becomes the **sigmoid flexure**. Each vertical portion of the colon lies against the kidney and the quadratus lumborum



INCISSIONS FOR DISSECTION.

muscle. The **sigmoid flexure** forms one or two folds in the left iliac fossa and hypogastrium before it passes into the pelvis, to become the **rectum**. The entire colon, with the exception of the hepatic and splenic flexures, is accessible to palpation. Masses of hardened feces in the colon and tumors of the colon may therefore be felt.

The **Small Intestine** is suspended by its mesentery in the median portion of the abdomen, below the umbilicus, and its area of tympany is bounded above by the transverse colon, and laterally by the ascending and descending colon.

The **Bladder**, when empty, lies entirely in the pelvic cavity, below the level of the crests of the pubic bones, but when full of urine, extends above the brim of the pelvis, and may extend as high as the umbilicus, displacing the small intestine posteriorly and laterally. A distended bladder is recognized by prominence of the lower portion of the abdomen and by a dull note on percussion and by fluctuation. Fluctuation is best elicited by placing the finger in the rectum in the male or in the vagina in the female, against the base of the bladder, and tapping the summit through the abdominal wall with the fingers of the disengaged hand.

THE ABDOMINAL PARIETES.

The **Thickness of the Abdominal Wall** varies in different locations and in individuals. The wall is thinnest at the linea alba. At the upper portion of the linea alba the superficial fascia and blended aponeuroses are so comparatively thin that an instrument will there enter the abdominal cavity with much more facility than elsewhere. The variation in the thickness of the wall in different individuals is chiefly produced by the superficial fascia. In emaciated persons the abdominal parietes may be so thin that the outlines of some of the viscera and the movements of the stomach and intestines can be seen imperfectly, and the organs be readily palpated; the loss of subcutaneous and extraperitoneal fat permits the parietes to collapse and become concave, instead of convex.

DISSECTION.—In dissecting the abdomen, blocks should be placed beneath the pelvis and shoulders; the block under the shoulders should be larger than that under the pelvis. When the abdominal wall is lax and flaccid, the dissection is facilitated by distending the abdomen with air, by means of a blow-pipe inserted through the umbilicus into the peritoneal cavity.

In reflecting the skin from the front and sides of the abdomen, but two incisions should be made. Each is commenced above, at the side of the chest, on a level with the sterno-ensiform joint, and carried downward in a straight line to the crest of the ilium; next, along the crest to the anterior superior spinous process of the ilium, and thence along the line of Poupart's ligament to the

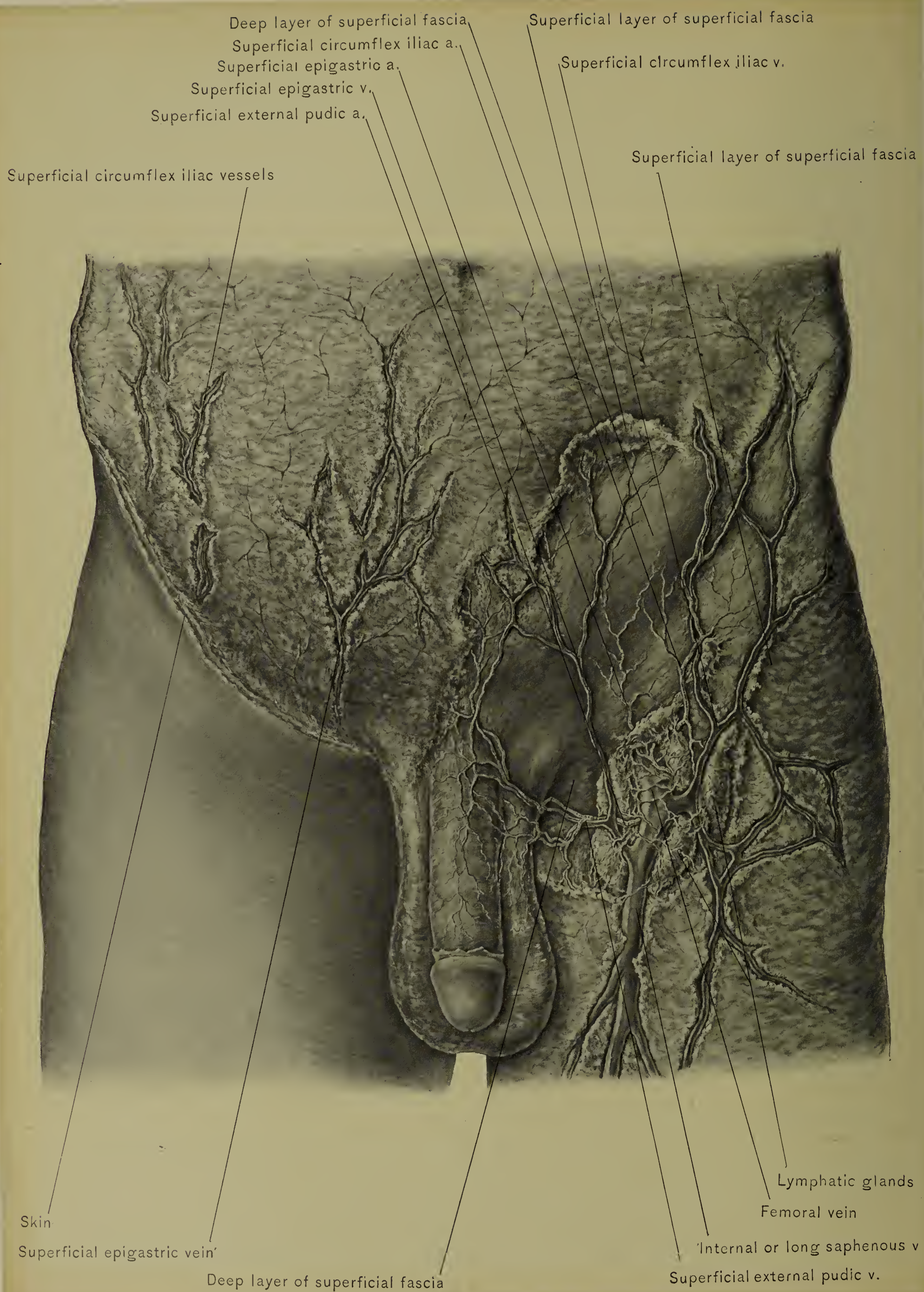
symphysis pubis, where the two incisions meet. Commencing below, the skin is dissected upward from the superficial fascia in one large flap. This large flap of skin gives an excellent covering for the remaining layers of the abdominal wall, and allows the student, when the flap is replaced, to review the surface anatomy of the part and study the relations which the deeper parts bear to the surface.

The **Superficial Fascia of the Abdomen**, continuous with the superficial fascia of the neighboring parts, consists of two layers, which are readily demonstrable by dissection, especially over the iliac regions. Running in this fascia are the subcutaneous vessels and nerves—viz., the superficial epigastric and the superficial circumflex iliac arteries and veins, branches of the superior epigastric, deep epigastric, and lower intercostal vessels, lateral and anterior cutaneous branches of the lower thoracic nerves, branches of the ilio-hypogastric and ilio-inguinal nerves, and some lymphatic vessels and glands.

The **superficial layer of the superficial fascia** contains the great bulk of the subcutaneous fat of this region. It is continuous with the same layer of the superficial fascia of the thigh, with the cellular tissue layer of the penis and scrotum, and with the superficial layer of the superficial fascia of the perineum. In very corpulent individuals the layer of subcutaneous fat, sometimes called the panniculus adiposus, is present here in greater thickness than elsewhere, being in some cases from four to six inches (ten to fifteen centimeters) in thickness; in such individuals an incision can be carried to some depth into this layer without dividing blood-vessels of any significance, since they are in the deeper part of the superficial fascia. The superficial layer is separated from Poupart's ligament by the superficial epigastric and superficial circumflex iliac vessels, the upper set of inguinal lymphatic glands, and the deep layer of the superficial fascia. This superficial layer is divisible into a number of layers in some bodies, while in others it is very thin and somewhat membranous near the thigh. In the female a thick deposit of fat in the superficial layer immediately above and over the bodies of the pubic bones produces an elevation—the *mons veneris*.

The **deep layer of the superficial fascia** of the abdomen (fascia of Scarpa) is thinner and more membranous than the superficial layer, and contains yellow elastic fibers. In this respect it resembles the tunica abdominalis of the lower animals, in whom it assists in the support of the abdominal viscera. It is closely attached to the outer lip of the crest of the ilium, the fascia lata immediately below Poupart's ligament, and the aponeurosis of the external oblique muscle, at the linea alba and linea transversa. Elsewhere it is loosely attached by areolar tissue to the underlying aponeurosis of the external oblique muscle.

The Scroto-abdominal Passageway.—Between the spine of the pubis and



SUPERFICIAL FASCIA OF THE ABDOMEN AND SUPERFICIAL VESSELS.

the symphysis pubis the deep layer of the superficial fascia is loosely attached to the underlying structures, passes downward over the spermatic cord and the body of the pubis, and becomes continuous with the dartos of the penis and scrotum. The space between the body of the pubis and the arch of the deep layer of the superficial fascia is the **scroto-abdominal passageway**. Extravasated urine which has reached the scrotum and distended it to its fullest capacity will pass upward to the abdominal wall through these two intervals, which are placed one upon each side of the symphysis pubis. Having reached the abdominal wall, the urine will be unable to pass downward upon the thigh or upon the gluteal region, on account of the attachment of the deep layer of the superficial fascia to the fascia lata near Poupart's ligament, and to the crests of the ilia, nor can it pass over the linea alba, on account of the attachment of the fascia to the aponeurosis along this line. Fluid beneath this layer is prevented from entering the inguinal canal by the inter-columnar fascia, which closes the external abdominal ring. Emphysematous collections following an injury to the chest,—*e. g.*, fracture of the ribs,—when beneath the deep layer of the superficial fascia, can not descend beyond the crest of the ilium or Poupart's ligament, or pass over the linea alba, on account of the attachments of the fascia, but can pass into the scrotum, and through it reach the perineum. If the air pass superficial to this layer, the emphysema may extend to the thighs. What has been said about a collection of air beneath this layer is equally true of a collection of pus.

An extension and a thickened portion of the deep layer of the superficial fascia, attached to the lower part of the linea alba and to the symphysis pubis, passes to the dorsum and sides of the penis, constituting the **Suspensory Ligament of the Penis**. Like the fascia from which it is derived, it is composed of fibro-elastic tissue.

The arrangement of the superficial fascia of the lower part of the abdomen of the female is similar to that of the male, with the exception that in the female the deeper layer is continuous with the dartos of the labia majora.

DISSECTION.—Upon one side of the lower part of the abdomen a quadrilateral area of the superficial layer of the superficial fascia should be reflected downward, slightly beyond the position of Poupart's ligament, to demonstrate the two layers of the superficial fascia. On the other side the superficial circumflex iliac and superficial epigastric vessels should be traced, and the oblique or superior set of inguinal lymphatic glands which are placed in the superficial fascia above and along the crease of the groin be noticed.

The **Superficial Epigastric Artery** is a branch of the common femoral, and ascends over Poupart's ligament near its center, running upward and inward toward the umbilicus, and anastomosing with cutaneous branches of the deep

epigastric artery. Usually it is a very small vessel with large venæ comites. From the relation which the superficial epigastric artery bears to the coverings of the inguinal canal it is quite evident that it will be divided in an operation for the relief of a strangulated inguinal hernia or for the radical cure of this form of hernia.

The **Superficial Circumflex Iliac Artery** is a branch of the common femoral. It pierces the fascia lata external to the saphenous opening, runs upward and outward upon the upper part of the thigh, crosses the outer end of Poupart's ligament, and divides into two branches which supply the integument of the lower part of the abdomen. It anastomoses with the deep circumflex iliac artery.

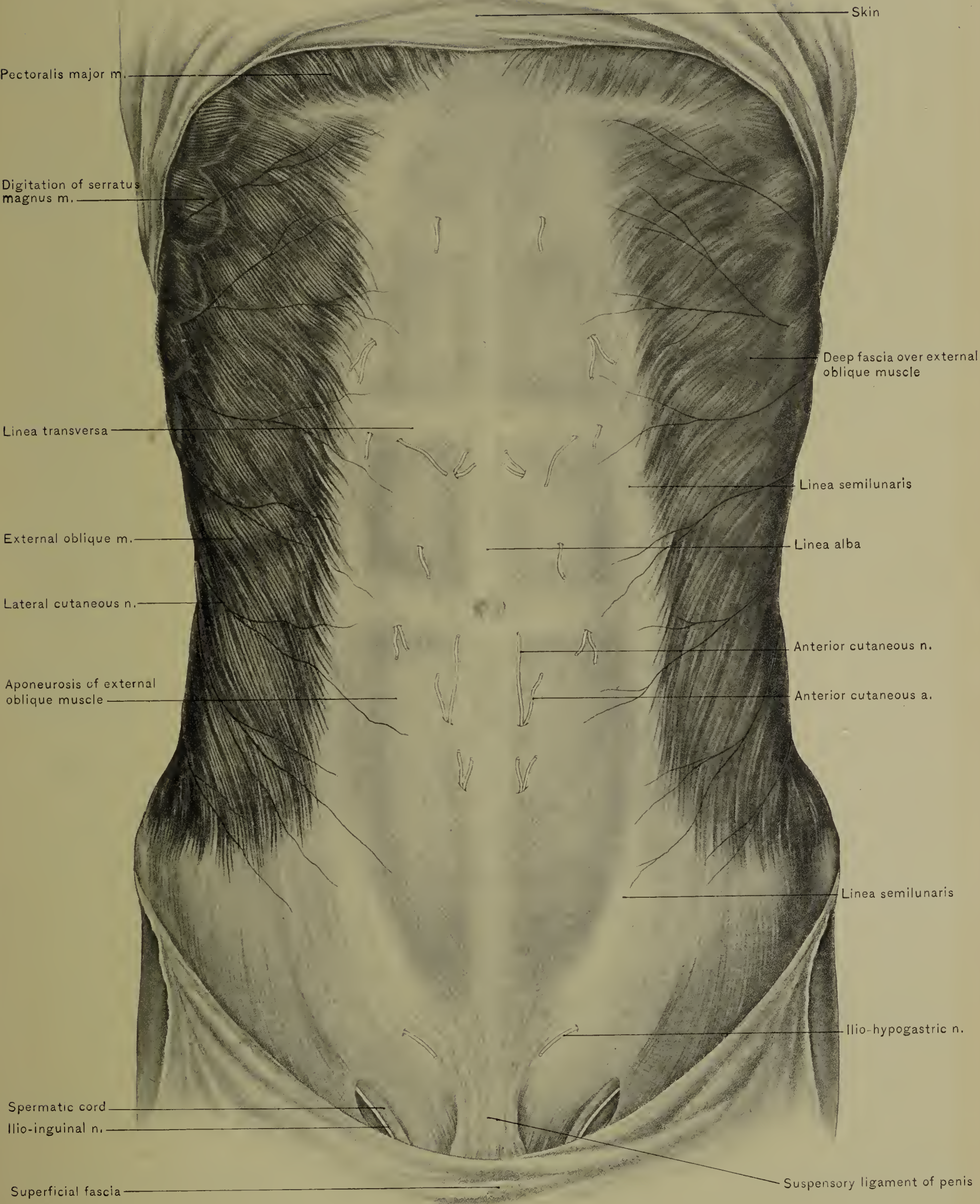
Superficial Veins.—The superficial epigastric and superficial circumflex iliac veins empty into the long saphenous vein; those accompanying the cutaneous twigs of the intercostal, deep epigastric, and superior epigastric arteries empty into the veins accompanying the arteries from which they arise.

The superficial veins upon the front of the abdomen are numerous, but distinct only when they are varicose or when the return circulation is obstructed. A lateral vein extending from the axilla to the groin and connecting the axillary and femoral veins may be rendered prominent. The surface abdominal vessels may or may not act as collateral blood channels in obstruction of the inferior vena cava. Clinical experience shows that these veins may also be enormously varicose where the return circulation through the inferior vena cava is not disturbed. It has been shown, moreover, that the valves of these vessels are so arranged that the blood in the surface veins above the umbilicus passes to the axilla, while the blood in the surface veins below the umbilicus passes to the groin. Schiff has shown that small veins connect the portal vein with the epigastric veins at the umbilicus.

The **Superior Set of Inguinal Lymphatic Glands** is situated between the two layers of the superficial fascia, over the line of Poupart's ligament. The glands are four or five in number. They receive the superficial lymphatics from the lower part of the abdominal wall, anterior part of the urethra, and from the integument of the perineum, anus, and gluteal region in both sexes. In the male they also receive the lymphatics from the integuments of the penis and scrotum, and in the female from the lower part of the vagina and integument of the clitoris and labia. The **Inferior Set of Inguinal Lymphatic Glands** is situated around the saphenous opening.

The **Superficial Lymphatic Vessels** of the abdominal wall accompany the superficial blood-vessels, those above the umbilicus going to the axillary glands, and those below to the superior set of inguinal glands.

The **Cutaneous Nerves** seen in the superficial fascia of the abdominal wall are



DEEP FASCIA, CUTANEOUS NERVES, EXTERNAL OBLIQUE MUSCLE AND ITS APONEUROSIS.

the lateral and the anterior cutaneous branches of the lower five or six intercostal nerves and branches of the ilio-hypogastric and ilio-inguinal nerves.

The **Lateral Cutaneous Nerves** emerge between the digitations of the external oblique muscle, in a line with the corresponding nerves found at the side of the upper part of the chest, the lower nerves emerging more posteriorly. They are accompanied by branches of the intercostal arteries. They divide into anterior and posterior branches. The *anterior branches* extend nearly as far forward as the outer margin of the rectus muscle, and are distributed to the overlying integument and the digitations of the external oblique muscle. The *posterior branches* are distributed to the skin over the latissimus dorsi muscle, where they inosculate with the dorsal cutaneous nerves. The lateral cutaneous, or iliac, branch of the last dorsal nerve is the largest, and, unlike the others, does not divide; it pierces both the internal and the external oblique muscle, and passes downward over the crest of the ilium, in front of the iliac branch of the ilio-hypogastric nerve, to supply the integument of the buttock and front of the hip, some of its filaments extending as low as the great trochanter.

The **anterior cutaneous nerves** are the terminal branches of the intercostal nerves, and are smaller, fewer in number, and less regular in situation than the lateral cutaneous nerves. They pierce the sheath of the rectus muscle, and supply the integument of the front of the abdomen. They are accompanied by the anterior cutaneous branches of the intercostal arteries.

In cases of Pott's disease of the vertebræ pain may be referred to the front of the abdomen, along the lower intercostal nerves.

The **Hypogastric Branch of the Ilio-hypogastric Nerve** enters the superficial fascia above and somewhat internal to the external abdominal ring.

The **Ilio-inguinal Nerve**, a branch of the first lumbar nerve, enters the superficial fascia at the external abdominal ring, through which it emerges from the inguinal canal to supply the integument of the upper and inner part of the thigh and of the scrotum or labia.

DISSECTION.—The superficial fascia should be reflected downward in one large flap. The deep fascia covering the external oblique muscle and the aponeurosis of the muscle will thus be exposed. While reflecting the superficial fascia, the cutaneous vessels and nerves previously described should be traced. Before removing the deep fascia, notice that the dartos of the penis and scrotum is continuous with the superficial fascia of the abdominal wall.

The **Deep Fascia of the Abdominal Wall** covers the external oblique muscle, and is a thin sheet of fascia readily demonstrable over the fleshy portion of the muscle, but intimately blended with the aponeurosis of the external oblique. This fascia is pierced by the lateral cutaneous nerves and accompanying blood-

vessels. It is continuous with the deep fascia of the chest, back, and thighs, and with that covering the gluteal muscles.

DISSECTION.—The deep fascia should be reflected from behind forward, cutting across or at right angles to the line of the muscular fibers.

The **External Oblique Muscle** arises from the outer and lower surface of the lower eight ribs by eight digitations. The upper five serrations interdigitate with corresponding processes of the serratus magnus; the lower three, with similar processes of the latissimus dorsi muscle. From this origin the fibers arising high up pass downward and forward, to terminate in the aponeurosis; those arising lower pass almost vertically downward, to be inserted into the anterior half of the outer lip of the crest of the ilium. The upper half of the posterior free border of the muscle is overlapped by the latissimus dorsi. The muscle is inserted into the anterior half of the outer lip of the crest of the ilium by muscular fibers, and into the anterior superior spine of the ilium, the deep fascia of the thigh, the spine of the pubis, the front of the body of the pubis, the symphysis pubis, and the linea alba by aponeurotic fibers.

BLOOD SUPPLY.—From the lower intercostal arteries and deep circumflex iliac artery.

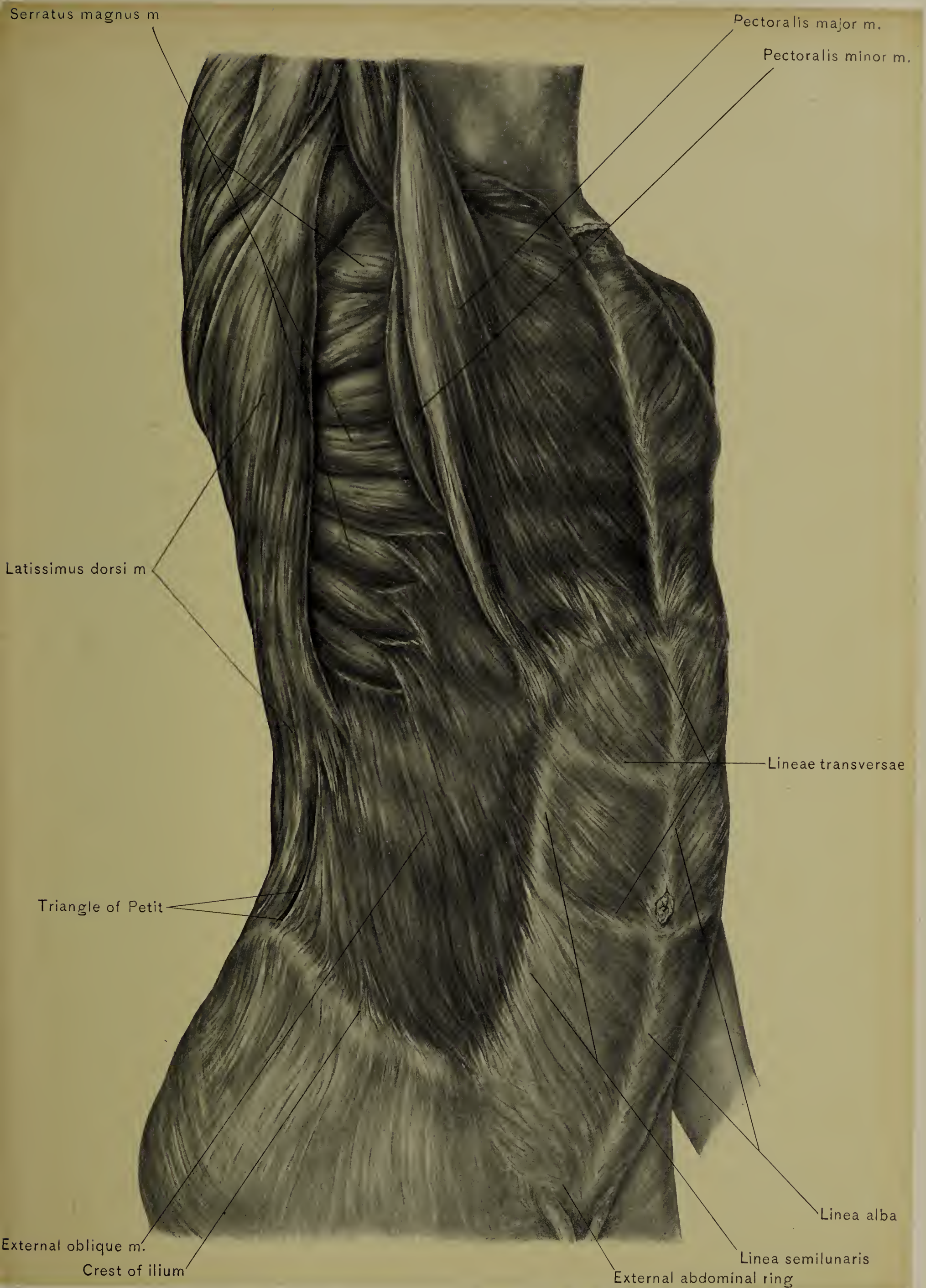
NERVE SUPPLY.—From the lower intercostal nerves, ilio-hypogastric, and ilio-inguinal nerves.

ACTION.—The function of the external oblique muscle is to aid in all efforts at micturition, defecation, parturition, and expiration. Acting together, the two muscles flex the pelvis on the thorax, or vice versâ; acting separately, each acts as a lateral flexor of the thorax on the pelvis, and also rotates the thorax on the pelvis, turning the thorax and upper part of the body toward the opposite side.

DISSECTION.—Before taking up the study of the aponeurosis of the external oblique muscle, the body should be turned slightly on the side opposite to that upon which the dissection is being made. By dissecting the skin and fasciæ backward for a short distance, a triangular intermuscular interval (triangle of Petit), situated immediately above the middle of the crest of the ilium, will be exposed.

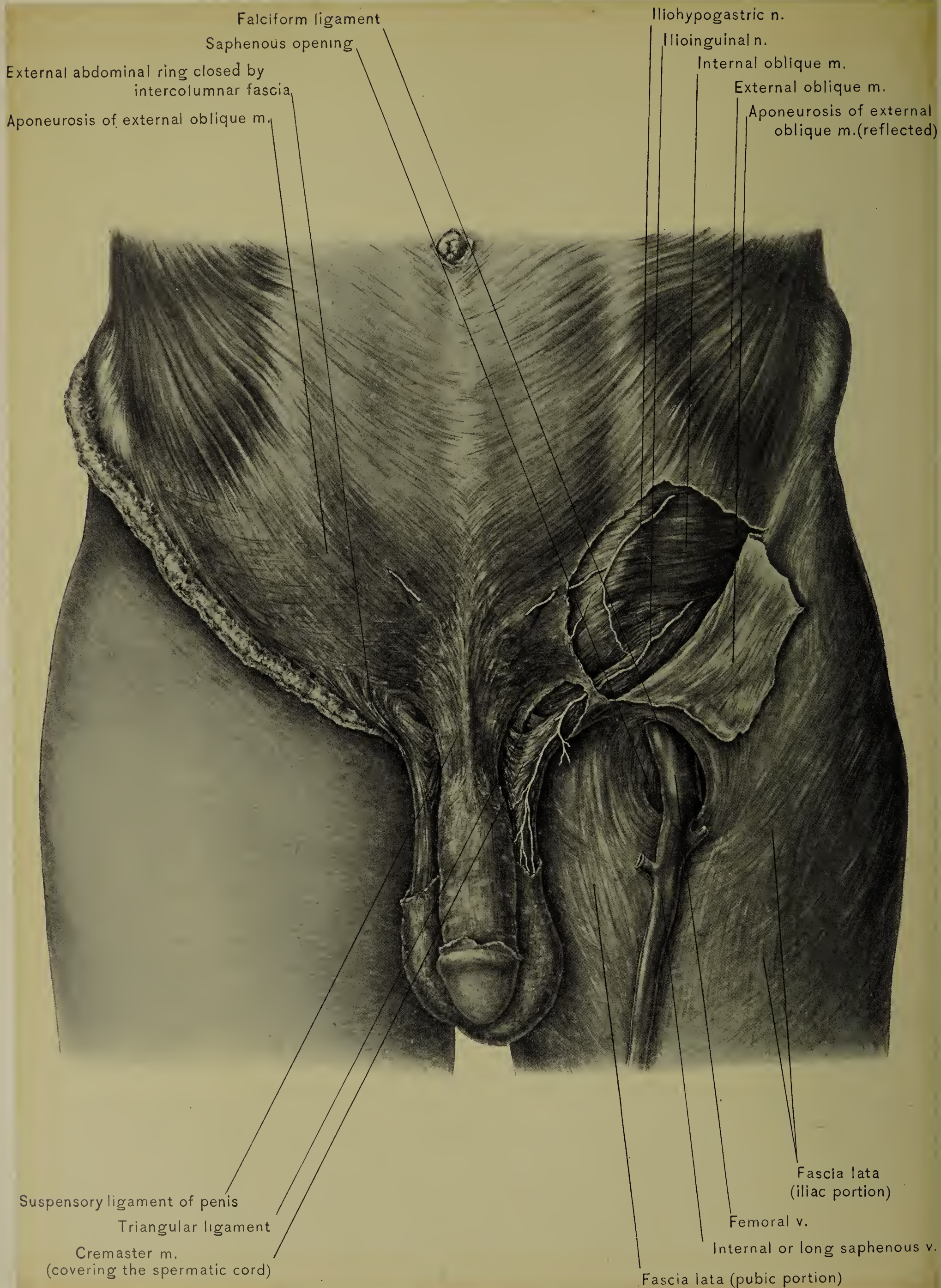
The **Triangle of Petit** is bounded below by the crest of the ilium, in front by the external oblique muscle, and behind by the latissimus dorsi muscle. In many instances, as in very muscular bodies, this interval is not present as a triangle, on account of the overlapping of the external oblique and latissimus dorsi muscles. It is important surgically because it is a weak place—at which a lumbar hernia or lumbar abscess bulges.

The **Aponeurosis of the External Oblique Muscle** covers the front of the abdomen, extending from the chest, where it is continuous with the origin of



EXTERNAL OBLIQUE AND LATISSIMUS DORSI MUSCLES, AND TRIANGLE OF PETIT.

PLATE CCCXXXII.



EXTERNAL ABDOMINAL RING, INTERCOLUMNAR FASCIA, SPERMATIC CORD, AND ILIO-INGUINAL NERVE.

the pectoralis major muscle, to the pelvis. Laterally it extends to a line drawn from the end of the cartilage of the ninth rib to a point about one and one-half inches (four centimeters) internal to the anterior superior spinous process of the ilium.

At the lower part of the abdomen it is broader, thicker, and, therefore, stronger, than it is above, greater strength being required at the lower part of the abdominal wall, where it supports the abdominal viscera.

The aponeurosis contains a number of small openings for the passage of cutaneous nerves and vessels, and a larger and more important opening, the external abdominal ring. In the fetus the umbilicus is an opening which pierces the aponeuroses of the two external oblique muscles, the aponeuroses of the internal oblique and transversalis muscles, and the transversalis fascia.

The **External Abdominal Ring** is situated in the lower part of the aponeurosis of the external oblique muscle, immediately above and slightly to the outer side of the spine of the pubis. It is somewhat triangular in shape, and is formed by the divergence of the fibers of the aponeurosis. The base of this triangular opening is at the pubic crest, the apex being directed obliquely upward and outward. Its longest diameter is about three-fourths of an inch (two centimeters). The diverging fibers of the aponeurosis forming the lateral boundaries of the opening constitute its **pillars**, or columns, of which there are two, the external and the internal. The **external pillar**, or column, blends with the inner end of Poupart's ligament, and is attached to the spine of the pubis. The spermatic cord, or the round ligament of the uterus, rests upon it. The **internal pillar**, or column, is attached to the front of the body and symphysis of the pubis.

The external abdominal ring gives passage, in the male, to the spermatic cord, the ilio-inguinal nerve, and the genital branch of the genito-crural nerve; in the female, to the round ligament of the uterus, the ilio-inguinal nerve, and the genital branch of the genito-crural nerve.

The external abdominal ring is readily felt by invaginating the scrotum over the end of the finger, and carrying it to the spine of the pubis, where it can be made to engage in the opening, which, in the average subject, will admit the tip of the index-finger. When there is doubt as to the presence of a small inguinal hernia, the diagnosis is materially assisted by engaging the tip of the finger first in the external abdominal ring of the side supposed to be affected, and then in the ring of the sound side, and noting the impulse perceived when the patient coughs. The impulse is more pronounced while the patient is in the erect posture.

The **Intercolumnar or External Spermatic Fascia** stretches across and closes the external abdominal ring, and is attached to the pillars of that ring. It is a continuation of the deep fascia which overlies the external oblique muscle, and it

is adherent to the aponeurosis of that muscle. As the external abdominal ring forms the outlet of the inguinal canal, it follows, therefore, that anything which passes out of the canal through its external opening must have for one of its coverings the intercolumnar or external spermatic fascia.

Derivatives of the External Oblique Muscle.—The aponeurosis of the external oblique muscle assists in forming the linea alba, and forms three ligaments—Poupart's, Gimbernat's, and the triangular ligament of the abdominal wall.

The **Linea Alba** extends from the ensiform cartilage to the symphysis pubis, and is wider above than below. The linea alba is the band of fibrous tissue which is situated between the rectus abdominis muscles, and is formed by the union of the aponeuroses of the flat muscles of the two sides of the abdominal wall by interlacement of their fibers.

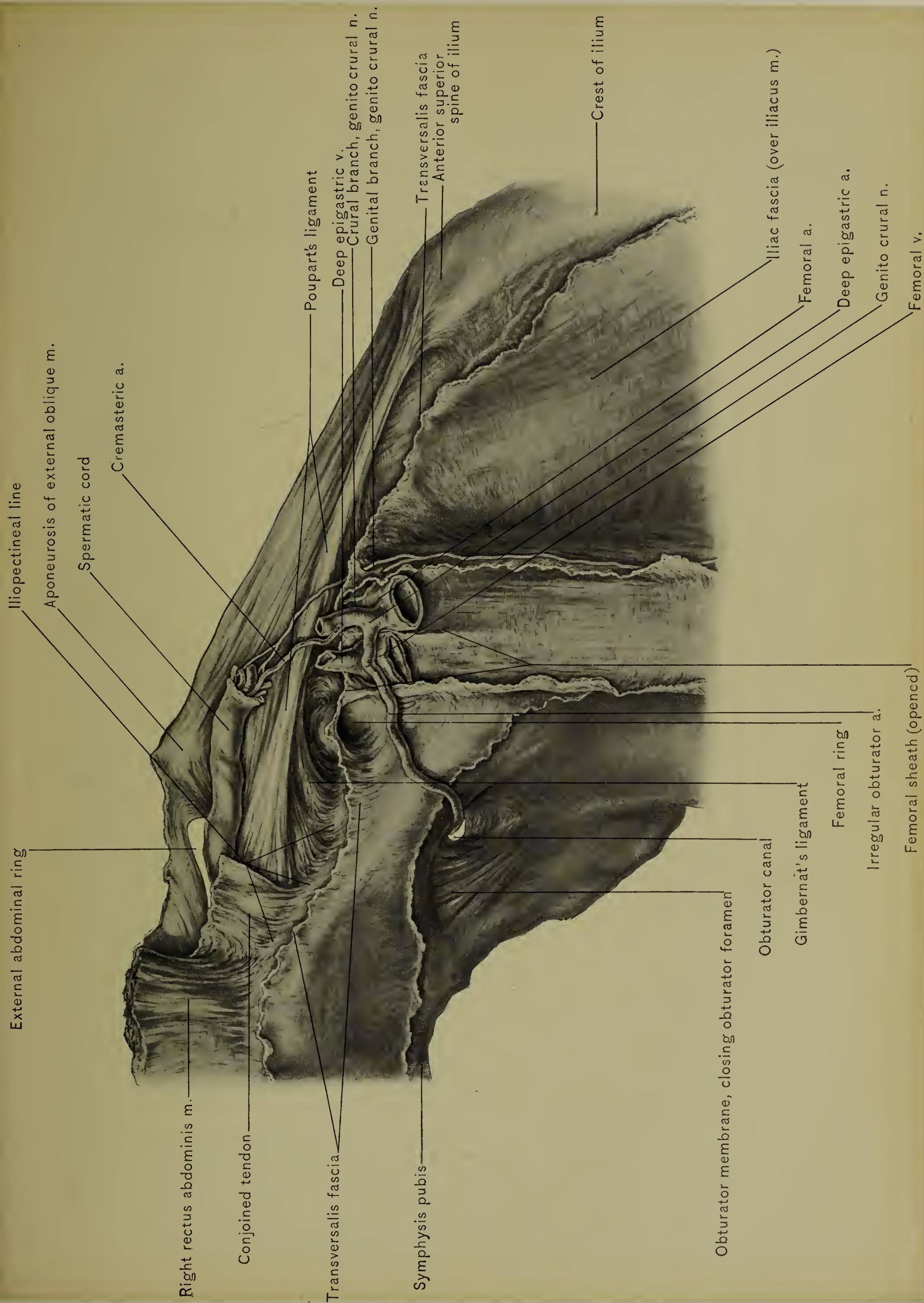
The width of the linea alba is increased by distention of the abdominal cavity by tumors, gas, or fluid.

Protrusions of masses of preperitoneal fat (**herniæ adiposé**) may occur through holes in the aponeurosis at the linea alba; or a **hernia of a part of the great omentum** may occur in the median line. The latter form of hernia at times causes digestive disturbances by dragging on the stomach.

The **Fibrous Ring of the Umbilicus** is situated in the blended aponeuroses of the linea alba, at or immediately below the center of that line. It is formed by the fibers of the aponeuroses, and is filled with cicatricial tissue which contains the remains of the two hypogastric arteries, umbilical vein, vitello-intestinal duct, and allantoic duct. The cord-like remains of these structures diverge as they leave the umbilicus, the round ligament of the liver or the remains of the umbilical vein passing upward, the urachus or remains of the allantoic duct and the remains of the hypogastric artery, downward.

The tension produced by the urachus depresses the scar downward and backward, thus attenuating the cicatricial tissue in the upper part of the ring; consequently herniæ more frequently protrude at the upper part of the ring.

Poupart's Ligament (crural or femoral arch) is the lower border of that portion of the aponeurosis of the external oblique muscle extending between the anterior superior spinous process of the ilium and the spine of the pubis. It crosses over the psoas and iliacus muscles, the external cutaneous, the anterior crural, the crural branch of the genito-crural, and the accessory obturator nerve and the common femoral vessels. The ligament is slightly curved, with the convexity downward. Continuous with its lower border is the fascia lata of the thigh. The attachment of the fascia lata to Poupart's ligament is especially to be borne in mind while making an attempt to reduce either an inguinal or a femoral hernia, when the leg is to be flexed on the thigh and the thigh on



POUPART'S AND GIMBERNAT'S LIGAMENTS.

the abdomen, and the entire limb adducted. By this manipulation the fascia lata and the ligament are rendered lax, thus placing the hernial orifice in the most favorable condition for the reduction of the protrusion. The ligament is more pronounced in men than in women, but in either sex it is the dividing line between the iliac and the inguinal region. The outer one-half of the ligament gives partial origin to the internal oblique muscle, and the outer one-third to the transversalis muscle. It is firmly united with the subjacent transversalis and iliac fasciæ.

Gimbernat's Ligament is that portion of the aponeurosis of the external oblique muscle attached to the ilio-pectineal line for about three-quarters of an inch (two centimeters) external to the spine of the pubis, and is, therefore, a reflection of Poupart's ligament. It is triangular in shape, with its base concave, free, and directed outward. Its base forms the inner boundary of the femoral ring.

The **Triangular Ligament of the Abdominal Wall** (Colles' ligament) is a small extension of the aponeurosis of the external oblique from the ilio-pectineal line to the linea alba, where it joins its fellow of the opposite side. It is, therefore, a reflection of Gimbernat's ligament. As the name indicates, it is of triangular shape, the apex of the triangle corresponding to its point of origin and the base to its point of insertion at the linea alba. It is situated in front of the conjoined tendon and the rectus and pyramidalis muscles.

DISSECTION.—On one side, the external oblique muscle should now be reflected forward. Detach it from the ribs by cutting through the muscle in front of the origins of the serrations. Divide the muscle just above the crest of the ilium, and the aponeurosis above and along Poupart's ligament, almost to the external pillar of the external abdominal ring. Above the crest of the ilium the interval between the external and internal oblique muscles can be recognized by a layer of fascia. The muscle should then be carefully separated from the subjacent tissue and displaced inward, exposing a distinct layer of fascia covering the internal oblique muscle, some nerves, and the space immediately above the inner half of Poupart's ligament—the inguinal canal. The spermatic cord, which lies in the inguinal canal, is seen to be partly covered by the cremaster muscle. The layer of fascia should next be removed carefully, from behind forward, thus exposing the internal oblique muscle, the hypogastric branch of the ilio-hypogastric nerve, and the ilio-inguinal nerve. The hypogastric branch of the ilio-hypogastric nerve pierces the aponeurosis of the external oblique muscle; and the ilio-inguinal nerve passes into the inguinal canal and runs in front of the spermatic cord in the male, or the round ligament of the uterus in the female.

The **Interabdominal Fasciæ**, so named from their position between the

abdominal muscles, are two in number. The more superficial one is situated between the external and the internal oblique muscle, while the deeper of the two lies between the internal oblique and transversalis muscles. These fasciæ are guides not only to the dissector in reflecting the external and internal oblique muscles, but also to the surgeon in operating through the muscles of the abdominal wall.

The **Internal or Ascending Oblique Muscle** arises from the outer half of Poupart's ligament, from the anterior two-thirds of the middle lip of the crest of the ilium, and from the lumbar fascia.

The fibers arising from the outer half of Poupart's ligament pass downward and inward, to terminate in the conjoined tendon with similar fibers of the transversalis muscle. These lower or **arching fibers of the internal oblique and transversalis muscles** are inserted, by means of the **conjoined tendon**, into the crest of the pubis, and for a short distance into the ilio-pectineal line and Poupart's ligament. The conjoined tendon is directly behind the external abdominal ring and the triangular ligament of the abdominal wall. At the point where the internal oblique muscle arises from Poupart's ligament it gives off from its lower border a detachment of fibers which passes downward with the spermatic cord and is called the **cremaster muscle**.

The fibers of the internal oblique arising from the anterior part of the middle lip of the crest of the ilium pass upward and inward, terminating in the aponeurosis of the muscle. The fibers arising from the posterior part of the middle lip of the crest of the ilium and the lumbar fascia pass almost directly upward, to be attached to the cartilages of the lower four ribs, blending with the internal intercostal muscles of the lower three intercostal spaces.

The **aponeurosis of the internal oblique muscle** extends from the chest to the pubis, being wider above than below. Along the outer border of the rectus muscle the aponeurosis, throughout its upper three-fourths, divides into two layers, one of which passes in front of, and the other behind, the rectus muscle, to join the aponeuroses of the external oblique and transversalis muscles and the corresponding layers of the aponeuroses of the opposite side at the linea alba. The anterior layer becomes inseparably united with the aponeurosis of the external oblique muscle. The line of junction of the aponeurosis of the external oblique and the aponeurosis of the internal oblique muscle is along the outer margin of the rectus muscle, at the upper part of the abdominal wall; but below the umbilicus the line of junction is in front of the rectus muscle and approaches the linea alba, thus forming two layers in the lower part of the anterior wall of the sheath of the rectus muscle. The posterior lamella of the aponeurosis of the internal oblique muscle blends with that of the transversalis muscle. Thus is formed the



TRANSVERSE SECTIONS OF ABDOMINAL WALL AND SHEATH OF RECTUS ABDOMINIS MUSCLE.



INTERNAL OBLIQUE MUSCLE.

upper three-fourths of the **sheath of the rectus muscle**; the sheath is described as being incomplete posteriorly at its lower fourth, where almost all the fibers of the aponeuroses of the internal oblique and transversalis muscles pass in front of the rectus, a few aponeurotic fibers passing behind the muscle. It must be clearly understood that the lower fourth of the posterior wall of the sheath of the rectus muscle is adherent to the transversalis fascia, and is so thin that this portion of the sheath has been described as absent. The lower border of the thicker portion of the posterior wall of the sheath of the rectus is concave, and receives the name **semilunar fold of Douglas**, or **plica semilunaris**. This fold marks the point where the deep epigastric artery enters the substance of the rectus muscle.

BLOOD SUPPLY.—From the superior epigastric, deep epigastric, deep circumflex iliac, and lower intercostal arteries.

NERVE SUPPLY.—From the lower intercostal nerves, the ilio-inguinal, and the ilio-hypogastric nerve.

ACTION.—The internal oblique muscle renders the abdominal wall tense, depresses the lower ribs, and compresses the viscera, assisting in defecation, micturition, parturition, and expiration.

Contraction of one muscle alone tends to rotate the chest to that side and to flex the thorax laterally. Acting from its insertion, it will flex the pelvis laterally and rotate it to the opposite side.

The **Cremaster Muscle** passes along the spermatic cord, through the inguinal canal and the external abdominal ring, into the scrotum. It reaches the portion of the internal spermatic fascia (fascia propria) which covers the tunica vaginalis, and turns upward to be inserted into the spine and crest of the pubis. The arrangement of the bundles of fibers of the muscle in the scrotum is in a series of loops united by connective tissue, hence the name **cremasteric fascia**. The size of the cremaster muscle depends upon the size of the testicle. The cremaster muscle is poorly developed in the female.

BLOOD SUPPLY.—From the cremaster branch of the deep epigastric artery.

NERVE SUPPLY.—From the genital branch of the genito-crural nerve.

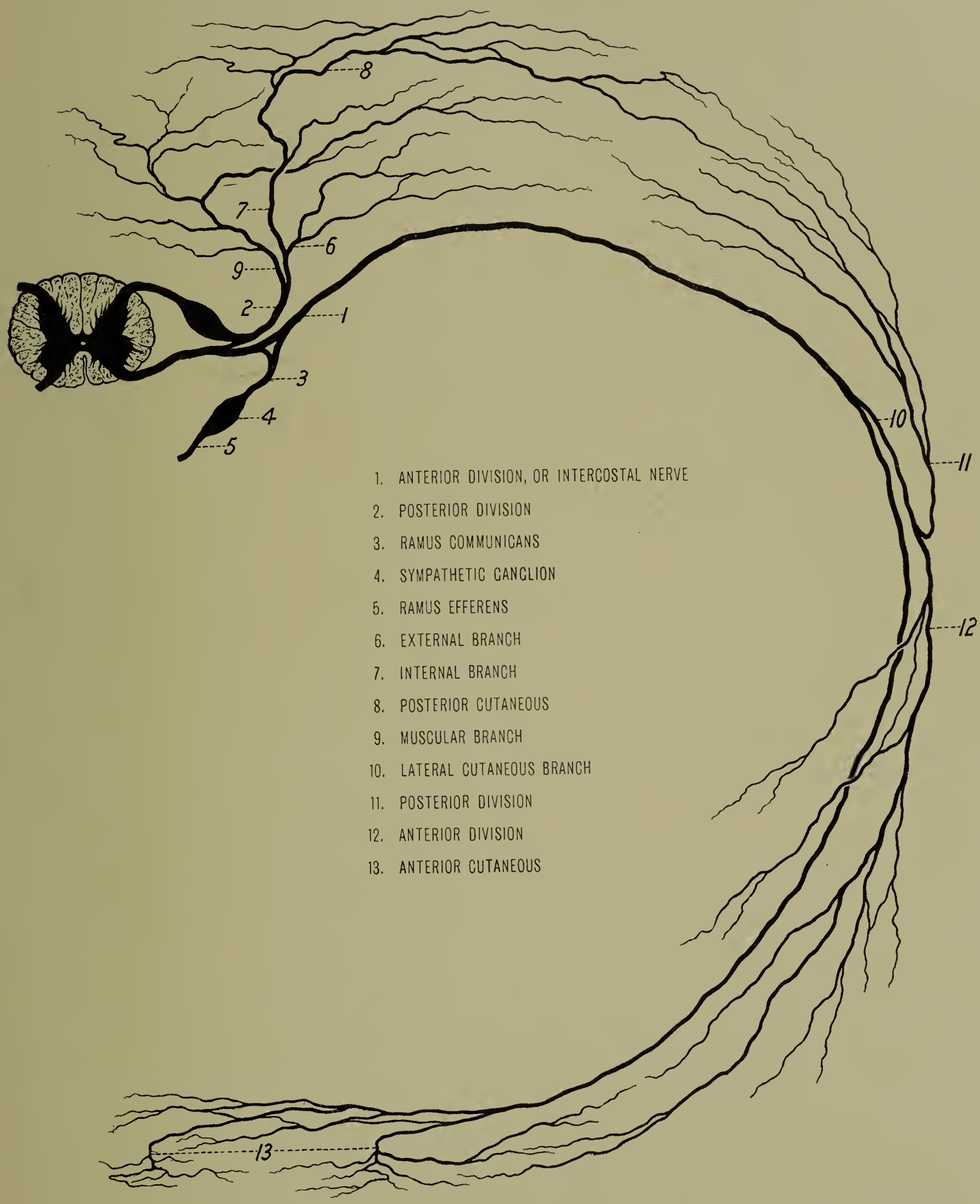
ACTION.—To support and elevate the testicle. Irritation of the skin of the upper and anterior part of the thigh at the area of distribution of the crural branch of the genito-crural nerve will usually be followed by drawing up of the testicle of the same side. This is the **cremasteric reflex**.

DISSECTION.—The internal oblique muscle should next be reflected on one side by taking it up from behind forward, first from the crest of the ilium, by making an incision parallel with, and a short distance above, the latter bone; the deep circumflex iliac artery and veins and the deep interabdominal fascia between the

internal oblique and transversalis muscles, which are important landmarks in the separation of these muscles, will be exposed, as well as portions of the lower intercostal, ilio-inguinal, and ilio-hypogastric nerves. The part of the muscle arising in common with the transversalis from the lumbar fascia should next be lifted, and, lastly, that arising from the outer half of Poupart's ligament. It should be noted that the lower fibers of the internal oblique muscle form part of the anterior boundary of the upper and outer portion of the inguinal canal. The muscle should be thrown forward and the deep interabdominal fascia removed, so that the lower intercostal nerves, the anterior branch of the last thoracic nerve, the ilio-hypogastric and ilio-inguinal nerves, the deep circumflex iliac artery and veins, the transversalis muscle, and the upper portion of both the spermatic cord or round ligament of the uterus and the inguinal canal may be exposed more thoroughly.

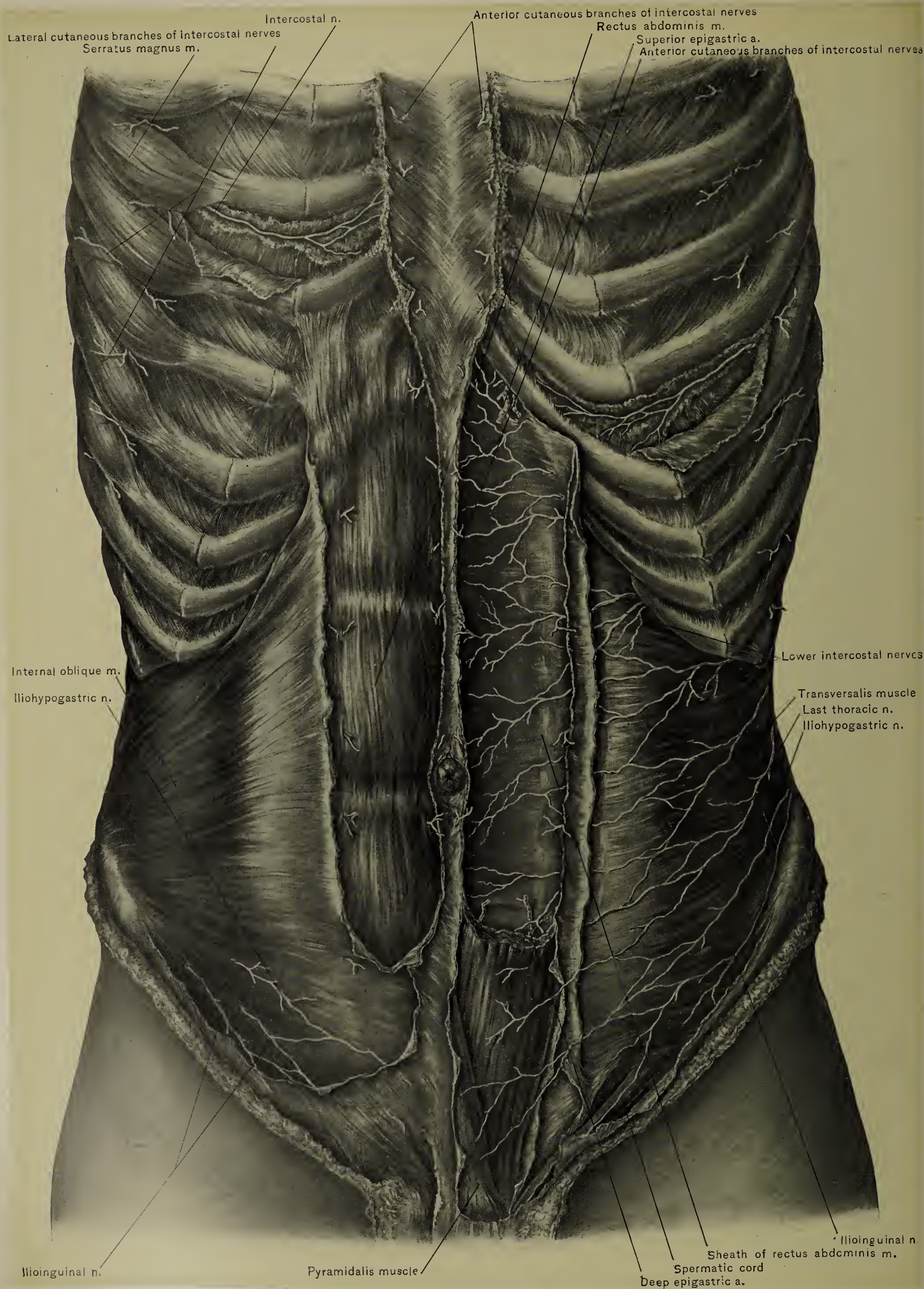
The **Six Lower Intercostal Nerves**, or anterior branches of the lower six thoracic nerves, are called abdominal intercostal nerves, as they supply the abdominal as well as the thoracic wall. The seventh to the eleventh intercostal nerves run for a distance between the ribs, and then pass between the transversalis and internal oblique muscles. They pierce the posterior lamella of the aponeurosis of the internal oblique, to supply the rectus muscle; and, finally, pierce the anterior wall of the sheath of the rectus as the **anterior cutaneous nerves**. About the middle of their course, at the side of the body, they give off **lateral cutaneous branches**, like the upper intercostal nerves. The anterior branch of the last, or twelfth, thoracic nerve is not an intercostal nerve because it runs below the last rib. It pierces the lumbar fascia near the origin of the transversalis muscle, and runs forward between the transversalis and internal oblique muscles. It gives off a lateral cutaneous branch which passes over the crest of the ilium to the gluteal region, and is called the **iliac branch**. The lower intercostal nerves supply the intercostal muscles, the levatores costarum, serratus posticus inferioris, transversalis, internal oblique, external oblique, rectus, and pyramidalis muscles. Their lateral cutaneous branches supply the external oblique muscle. Their course in the belly-wall is in the direction of the ribs, the tenth intercostal nerve supplying the region of the umbilicus. In shingles, or herpes zoster, perineuritis, or inflammation of the sheaths of one or two of these nerves, produces pain, which is referred to their area of distribution, where trophic disturbances in the skin cause vesicles and erythema.

The **Ilio-hypogastric and Ilio-inguinal Nerves** are branches of the first lumbar nerve. They both pierce the transversalis muscle close to the crest of the ilium, and run forward along the crest of the ilium, between the transversalis and internal oblique muscles. The ilio-hypogastric nerve gives off an



- 1. ANTERIOR DIVISION, OR INTERCOSTAL NERVE
- 2. POSTERIOR DIVISION
- 3. RAMUS COMMUNICANS
- 4. SYMPATHETIC GANGLION
- 5. RAMUS EFFERENS
- 6. EXTERNAL BRANCH
- 7. INTERNAL BRANCH
- 8. POSTERIOR CUTANEOUS
- 9. MUSCULAR BRANCH
- 10. LATERAL CUTANEOUS BRANCH
- 11. POSTERIOR DIVISION
- 12. ANTERIOR DIVISION
- 13. ANTERIOR CUTANEOUS

DIAGRAM OF A LOWER INTERCOSTAL NERVE.



LOWER INTERCOSTAL NERVES, TRANSVERSALIS AND RECTUS ABDOMINIS MUSCLES.

iliac branch, which pierces the internal and external oblique muscles two and one-half to three inches (six to seven centimeters) behind the anterior superior iliac spine, runs obliquely forward, and supplies the skin as low as the great trochanter. The **hypogastric branch** is the continuation of the nerve; it pierces the internal oblique muscle on a level with the anterior superior spine of the ilium, runs inward, and pierces the aponeurosis of the external oblique aponeurosis above the external abdominal ring. The ilio-inguinal nerve pierces the internal oblique muscle below and to the inner side of the anterior superior iliac spine, runs downward and inward over the cremaster muscle, near and above Poupart's ligament, and passes through the external abdominal ring to supply the skin around the external abdominal ring and integument of the scrotum, or labium majus.

The **Deep Circumflex Iliac Artery** arises from the outer side of the external iliac artery, about one-fifth of an inch (0.5 centimeter) above Poupart's ligament. It runs outward under Poupart's ligament, in the subperitoneal fat, or between the peritoneum and the transversalis fascia, and along the line of junction of the iliac and transversalis fascia. It pierces the transversalis fascia and transversalis muscle just internal to the anterior superior spine of the ilium, and runs outward between the transversalis and internal oblique muscles just above, and parallel with, the crest of the ilium. It gives off an ascending branch which passes upward between these muscles. It is accompanied by two veins, which unite into a single vein that crosses the external iliac artery and empties into the external iliac vein. It anastomoses with the lower intercostal, lumbar, ilio-lumbar, superficial circumflex iliac, and superior gluteal arteries.

The **Transversalis Muscle** arises from the outer one-third of Poupart's ligament, the anterior two-thirds of the inner lip of the crest of the ilium, the lumbar fascia, and the inner surface of the lower six costal cartilages, interdigitating with the diaphragm. All the fibers of the transversalis muscle with the exception of those which arise from the outer third of Poupart's ligament pass transversely inward, terminating near the outer border of the rectus muscle in an aponeurosis which is wider below than above, but widest in the center. The uppermost fibers of the muscle almost reach the linea alba before becoming aponeurotic. It is inserted, by means of an aponeurosis, into the linea alba, crest of the pubis, and iliopectineal line. The aponeurosis in its upper three-fourths passes, with the posterior layer of the aponeurosis of the internal oblique muscle, behind the rectus, while the lower fourth passes with the undivided portion of the aponeurosis of the internal oblique muscle in front of the rectus muscle, to join the aponeurosis of the transversalis muscle of the opposite side along the middle line, and thus be inserted into the linea alba. A stratum of aponeurotic fibers does pass behind the lower one-fourth of the rectus, but it is much thinner than the posterior wall of the upper

three-fourths of the sheath, the sudden diminution in the thickness of which produces the **semilunar fold of Douglas**. The fibers of the transversalis muscle arising from the outer one-third of Poupart's ligament take the same course as do the similar fibers of the internal oblique muscle—namely, downward and inward, terminating with the latter in the conjoined tendon. These fibers, unlike those of the internal oblique arising from the outer half of Poupart's ligament, do not normally form any part of the anterior boundary of the inguinal canal, but simply a part of the upper boundary. The spermatic cord has been seen piercing the lower border of the transversalis muscle (Guthrie); under these circumstances the transversalis muscle would enter into the anterior boundary of the canal.

The **conjoined tendon** is situated immediately behind the external abdominal ring, and as it is the common tendon of insertion of the fibers of the internal oblique and transversalis muscles arising from Poupart's ligament, it is the lower part of the common aponeurosis of these muscles. The aponeurosis of the transversalis muscle forms the greater part of the tendon, as it is attached to the iliopectineal line and Poupart's ligament to the extent of one inch (2.5 centimeters), while the aponeurosis of the internal oblique is attached to the line only to the extent of about one-half inch (1.25 centimeters). In closing the inguinal canal in the operation for the radical cure of inguinal hernia the rectus muscle, conjoined tendon, and transversalis fascia are stitched to the shelving posterior border of Poupart's ligament.

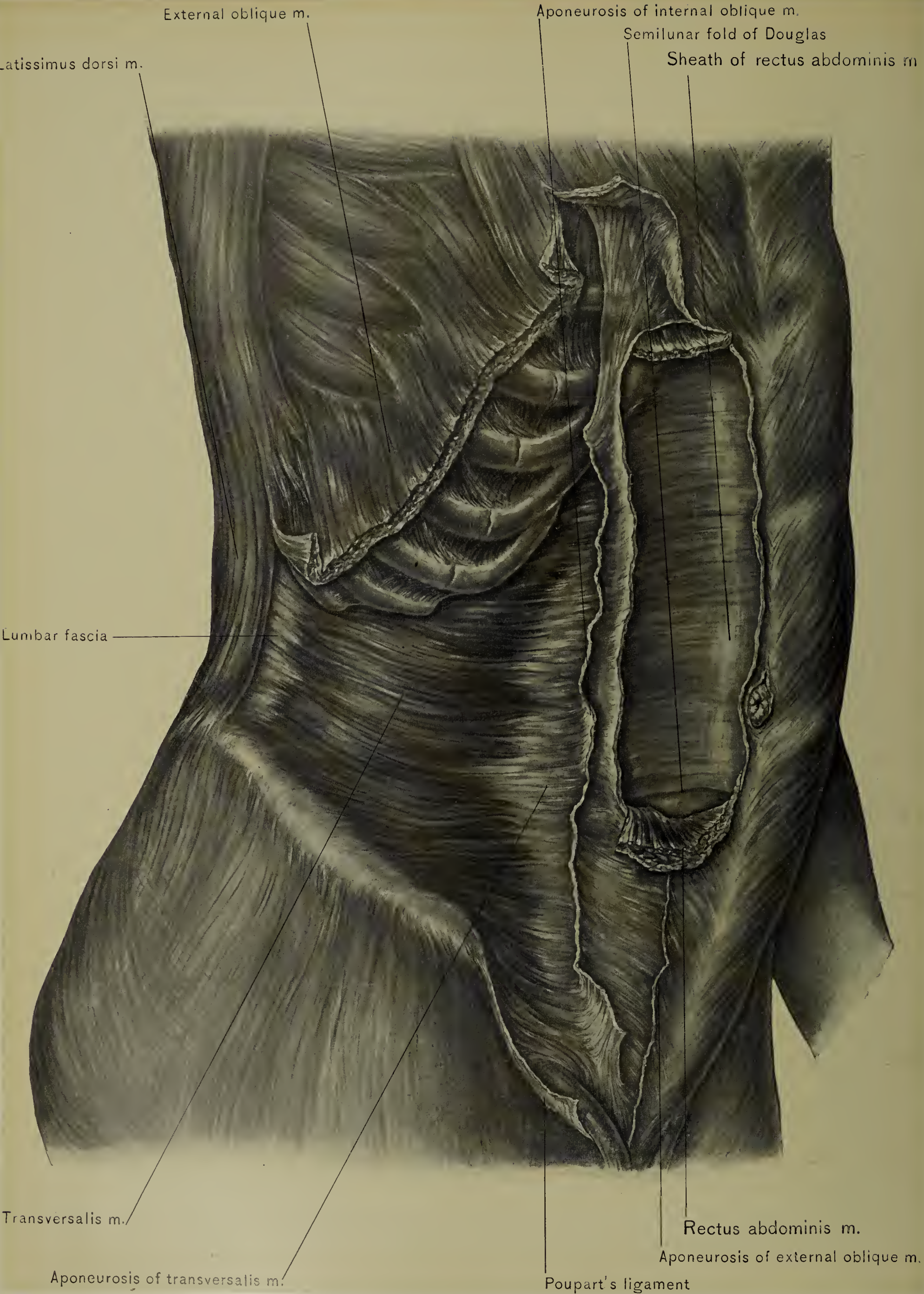
BLOOD SUPPLY.—From the deep epigastric, superior epigastric, deep circumflex iliac, lumbar, and lower intercostal arteries.

NERVE SUPPLY.—From the anterior primary branches of the lower intercostal nerves and from the ilio-hypogastric and ilio-inguinal nerves.

ACTION.—The action of the transversalis muscle is to compress the contents of the abdomen, assisting in micturition, defecation, parturition, and expiration.

A collection of pus in the abdominal wall between two of the large flat muscles may burrow along the interabdominal fascia; vertically it may burrow from the attachments of the muscles and fasciæ to the thorax, to the crest of the ilium and Poupart's ligament, and along the spermatic cord into the scrotum; laterally it may burrow in the anterior and lateral abdominal wall from about opposite the middle of the crest of the ilium, where the fasciæ spring from the lumbar fascia, to an irregular line just internal to the linea semilunaris, where the aponeuroses blend in the walls of the sheath of the rectus muscle. Hemorrhagic and emphysematous effusions take the same course.

The **difference in direction of the fibers of the three flat abdominal muscles** serves to strengthen the parietes of the abdomen. In some operations the incisions through the muscles are made in the direction of the muscular fibers; incisions



TRANSVERSALIS MUSCLE AND SHEATH OF RECTUS ABDOMINIS MUSCLE.

which transversely divide the fibers of one of these muscles will be more likely to be followed by weakening of the abdominal wall and a hernia than if the incisions were made parallel with the fibers of the muscles. In the incision for removal of the appendix vermiformis, suggested by McBurney, the muscles are not cut at all, the fibers of the aponeurosis of the external oblique and the fibers of the internal oblique and transversalis muscles simply being separated.

DISSECTION.—The rectus abdominis muscle should be exposed by making a vertical incision extending from the chest to the body of the pubis, through the anterior layer of the sheath of the muscle. The two portions of the sheath should be reflected laterally, to accomplish which the adhesions between the upper part of the anterior wall of the sheath and the tendinous intersections in the rectus (*lineæ transversæ*) must be divided. In addition to the rectus muscle the pyramidalis muscle, situated immediately above the pubis, in front of the rectus, should be exposed.

The **Rectus Abdominis Muscle** is long, thin, and ribbon-like, and is situated between the linea alba and linea semilunaris, inclosed by a sheath formed by the aponeuroses of the three flat muscles of the abdomen. It extends from the pubis to the chest, and is separated from its fellow of the opposite side by the linea alba. It is narrowest below and widest above. It arises by two heads: the inner, or smaller, springs from the ligamentous tissue in front of the symphysis pubis, where it blends with the inner head of the corresponding muscle of the opposite side, and the outer, or larger, head arises from the crest of the pubis. It passes upward, becoming broader and thinner, and is inserted into the outer surface of the chondral end of the fifth rib and the fifth, sixth, and seventh costal cartilages. In some subjects fibers of the muscle are attached to the ensiform cartilage. There are three *tendinous intersections* in the rectus muscle: one is situated opposite the umbilicus, one between the umbilicus and the ensiform cartilage, and one on a level with the ensiform cartilage. These fibrous intersections are closely adherent to the anterior wall of the sheath of the rectus, but not to the posterior wall, so that pus formed within the upper part of the sheath of the muscle would not necessarily be confined by the intersections. On account of its length and ribbon-like form, some of the bundles of fibers of the rectus abdominis muscle are occasionally ruptured by muscular violence.

BLOOD SUPPLY.—From the superior epigastric, deep epigastric, and intercostal arteries.

NERVE SUPPLY.—From the lower intercostal nerves and the ilio-hypogastric branch of the lumbar plexus.

ACTION.—The rectus abdominis muscles, when acting from below, depress the

thorax and flex the vertebral column; when acting from above, they flex the pelvis upon the vertebral column.

The **Pyramidalis Muscle** is situated in front of the lower end of the rectus, and is triangular in shape. It arises by its base from the front of the body of the pubis and from the anterior pubic ligament, and is inserted by its apex into the linea alba, midway between the umbilicus and the pubis. It is sometimes absent on one or both sides.

NERVE SUPPLY.—From the lower intercostal nerves and the ilio-hypogastric nerve.

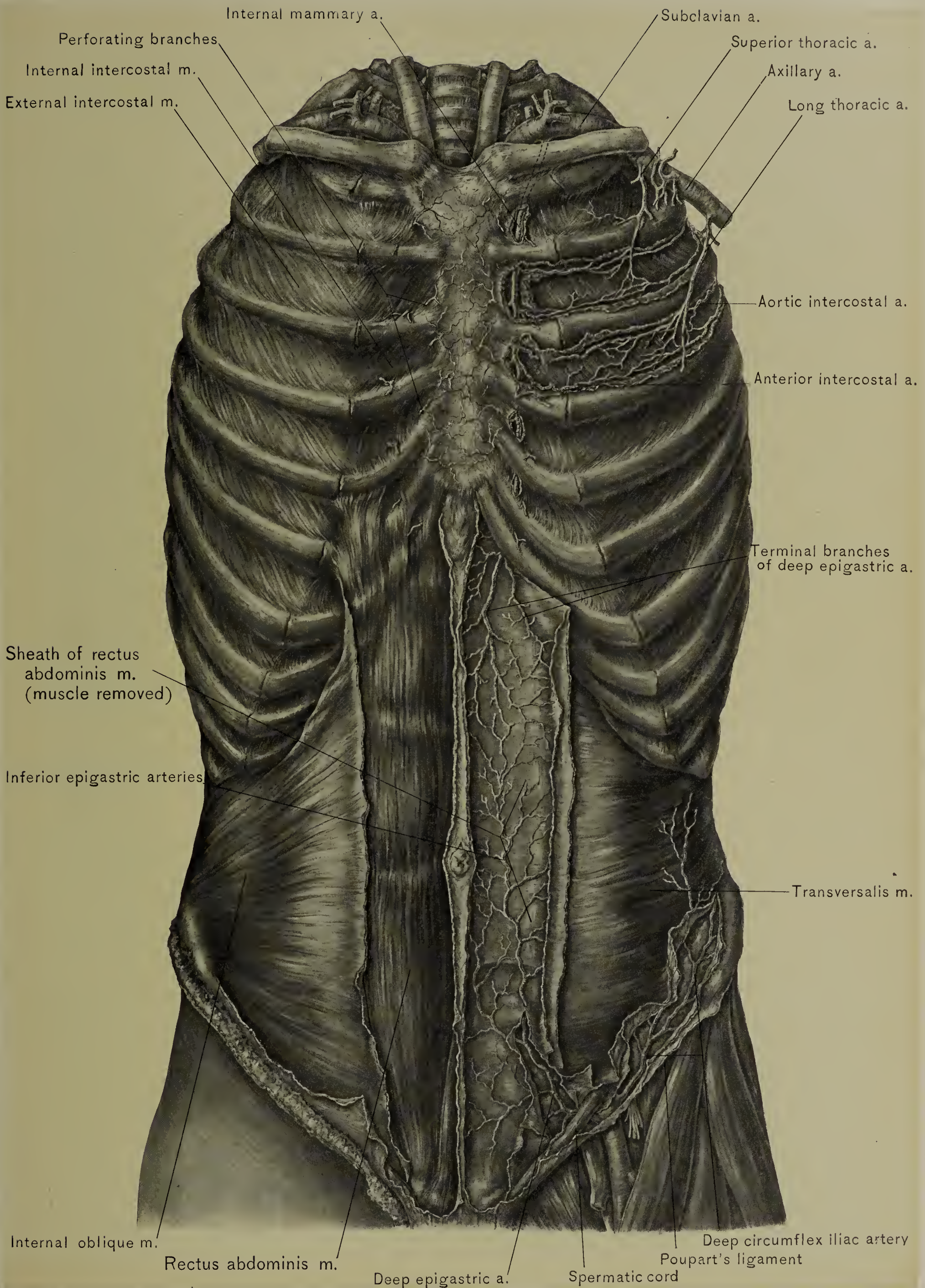
ACTION.—Contraction of the pyramidales makes the linea alba tense.

In opening the abdomen through the linea alba or through the linea semilunaris, when neither line is exposed directly by the incision through the skin and superficial fascia, the anterior layer of the sheath of the rectus muscle should be immediately opened, as the anterior wall of the sheath can be stripped from the muscle and either the linea alba or the linea semilunaris quickly reached.

The **Sheath of the Rectus Abdominis Muscle**, which has been described with the internal oblique muscle, contains the rectus abdominis and pyramidalis muscles, the superior epigastric artery and its venæ comites, the terminal portion of deep epigastric artery and its venæ comites, and is traversed by the lower intercostal nerves.

The **Superior Epigastric Artery** is the innermost of the two terminal branches of the internal mammary artery, and is the continuation of that artery. It emerges from the thorax by passing between the costal and xiphoid origins of the diaphragm, and behind the seventh costal cartilage, to enter the sheath of the rectus abdominis muscle. It runs between the muscle and posterior wall of its sheath, about midway between the borders of the muscle, enters the muscle, and anastomoses with the deep epigastric artery about midway between the umbilicus and the xiphoid cartilage. Its branches are phrenic, xiphoid, muscular to the rectus and the oblique muscles, cutaneous, and peritoneal.

The **Deep Epigastric Artery** arises from the external iliac artery immediately above Poupart's ligament. It passes upward and inward in the extraperitoneal fat, or between the peritoneum and transversalis fascia, toward the semilunar fold of Douglas, just below which it pierces the transversalis fascia and enters the sheath of the rectus abdominis muscle. It runs upward between the rectus and the posterior wall of its sheath, about midway between the borders of the muscle, finally ramifying in the muscle and anastomosing with the superior epigastric artery. Just above its origin it passes on the inner side of the internal abdominal ring, and the spermatic vessels and vas deferens turn around its outer side, curving it slightly inward. All oblique inguinal herniæ pass on its outer side,



EPIGASTRIC AND DEEP CIRCUMFLEX ILIAC ARTERIES.

and direct inguinal herniæ pass on its inner side. It gives off cremasteric, pubic, peritoneal, muscular, and cutaneous branches.

The **cremasteric branch of the deep epigastric artery** supplies the cremaster muscle and the other coverings of the spermatic cord, and anastomoses with the spermatic, superficial external pudic, and superficial perineal arteries. Through its anastomosis with the spermatic artery it furnishes the blood supply of the testicle after division of the spermatic artery in the operative treatment of varicocele. The **pubic branch** passes inward, either above or below the femoral ring, to the posterior surface of the body of the pubic bone. This artery gains importance from being abnormally large and continuing as the obturator artery in 28.5 per cent. of subjects. When the anomalous obturator artery runs above and on the inner side of the femoral ring, which occurs in about 1.43 per cent. of subjects, it passes only about one-eighth inch (three millimeters) from the margin of the femoral ring, so that it might be severed by a deep incision to relieve constriction of a hernia at the femoral ring.

The muscles of the abdominal wall form an elastic support and a protection for the abdominal viscera.

Blows upon the Abdomen which would not do much harm to the viscera if they were anticipated, so that the muscles would be tense and ready to protect the abdominal organs, may seriously injure these viscera if they are received unexpectedly. An anticipated blow may bruise the abdominal wall extensively and not injure the viscera, whereas an unexpected blow may injure the abdominal viscera seriously without inflicting visible injury on the abdominal wall. A blow upon the epigastrium may cause death by concussion of the solar plexus, and the abdominal wall moves so freely over the viscera that the liver, intestine, stomach, or bladder may be ruptured with slight or no external signs of traumatism.

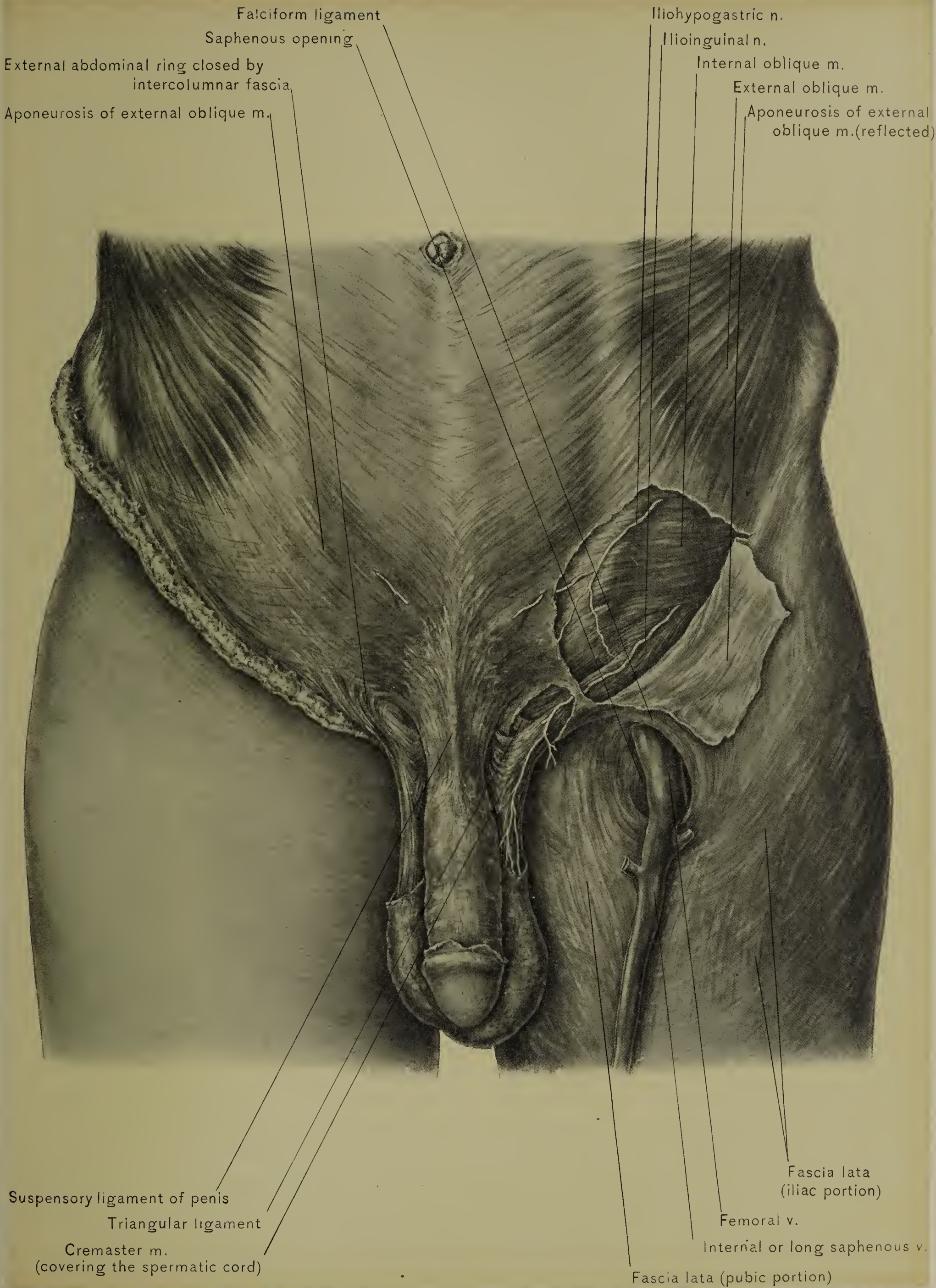
DISSECTION.—Reflect the transversalis muscle forward in the same manner as the internal oblique, to expose the transversalis fascia.

The **Transversalis Fascia** lines the internal surface of the transversalis muscle. It is a thin layer of fascia which is placed between the extraperitoneal fatty tissue and the abdominal muscles and their aponeuroses. The fascia of one side is continuous with that of the other at the linea alba, and thus forms an extensive lining membrane for the muscles of the anterior and lateral portions of the abdominal wall. It is attached laterally to the inner lip of the crest of the ilium, where it becomes continuous with the iliac fascia. In front it is attached to the outer half of Poupart's ligament, where it is continuous with the iliac fascia. Opposite the common femoral vessels it dips beneath Poupart's ligament to form the anterior part of the sheath of those vessels. To the inner side of the

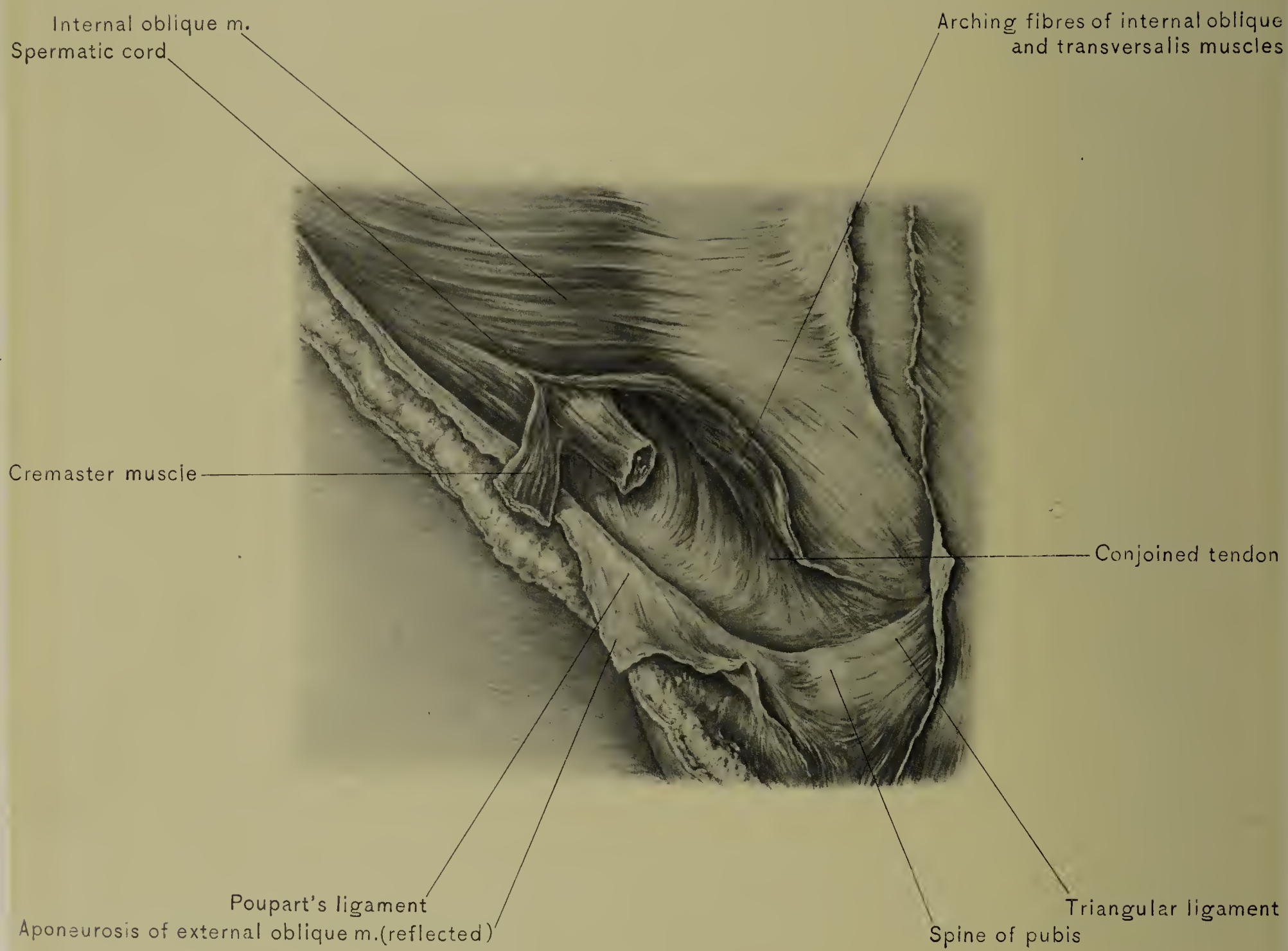
common femoral vessels it is attached to the ilio-pectineal line, lying behind the conjoined tendon, to which also it is partially attached. It is closely adherent to the under surface of the aponeurosis of the transversalis muscle. The transversalis fascia is quite thin above, where it becomes continuous with the thin fascia on the abdominal surface of the diaphragm; below it is firmer and thicker. In the inguinal region it closes the gap between Poupart's ligament and the arching fibers of the internal oblique and transversalis muscles. At from one-half to three-fourths of an inch (1.25 to 1.5 centimeters) above the middle of Poupart's ligament the transversalis fascia contains an opening,—the **internal abdominal ring**,—through which pass the constituents of the spermatic cord; these structures are covered by a funnel-shaped prolongation of the transversalis fascia known as the **infundibuliform fascia**. This opening in the transversalis fascia (internal abdominal ring) is very important, as it forms the inlet to the inguinal canal, through which an indirect or oblique inguinal hernia must pass. The internal abdominal ring is round in the infant; but in the adult it is oval, as a result of the traction produced by the vas deferens. As it is about one-half inch (1.25 centimeters) above the center of Poupart's ligament, it is covered by the lower fibers of the internal oblique muscle.

DISSECTION.—Upon the side from which the muscles have not been reflected mark out, just above the inner two-thirds of Poupart's ligament, a quadrilateral flap of the aponeurosis of the external oblique about two inches (five centimeters) in width, and reflect it downward to Poupart's ligament, giving an instructive view of the inguinal canal.

The **Inguinal Canal** is a space in the lower part of the abdominal wall, immediately above and nearly parallel with the inner one-half of Poupart's ligament. It extends from the internal abdominal ring to the external abdominal ring, and is one and one-half inches (four centimeters) in length in the male, and two inches (five centimeters) in length in the female. Its greater length in the female is due to the wider separation of the iliac bones in that sex. Accurately speaking, it is not a space, but is occluded by the apposition of its anterior and posterior walls. It is bounded in front by the aponeurosis of the external oblique muscle throughout, and the lower fibers of the internal oblique at its outer one-third; behind, by the triangular ligament of the abdominal wall at its inner end, and by the conjoined tendon and transversalis fascia; above, by the arching fibers of the internal oblique and transversalis muscles; and below, by Poupart's ligament, to the posterior shelving margin of which the transversalis fascia is attached, and for a short distance at its inner end by Gimbernat's ligament. Its *contents* in the male are the spermatic cord, the ilio-inguinal nerve, which lies in front of the cord, and the genital branch of the genito-crural



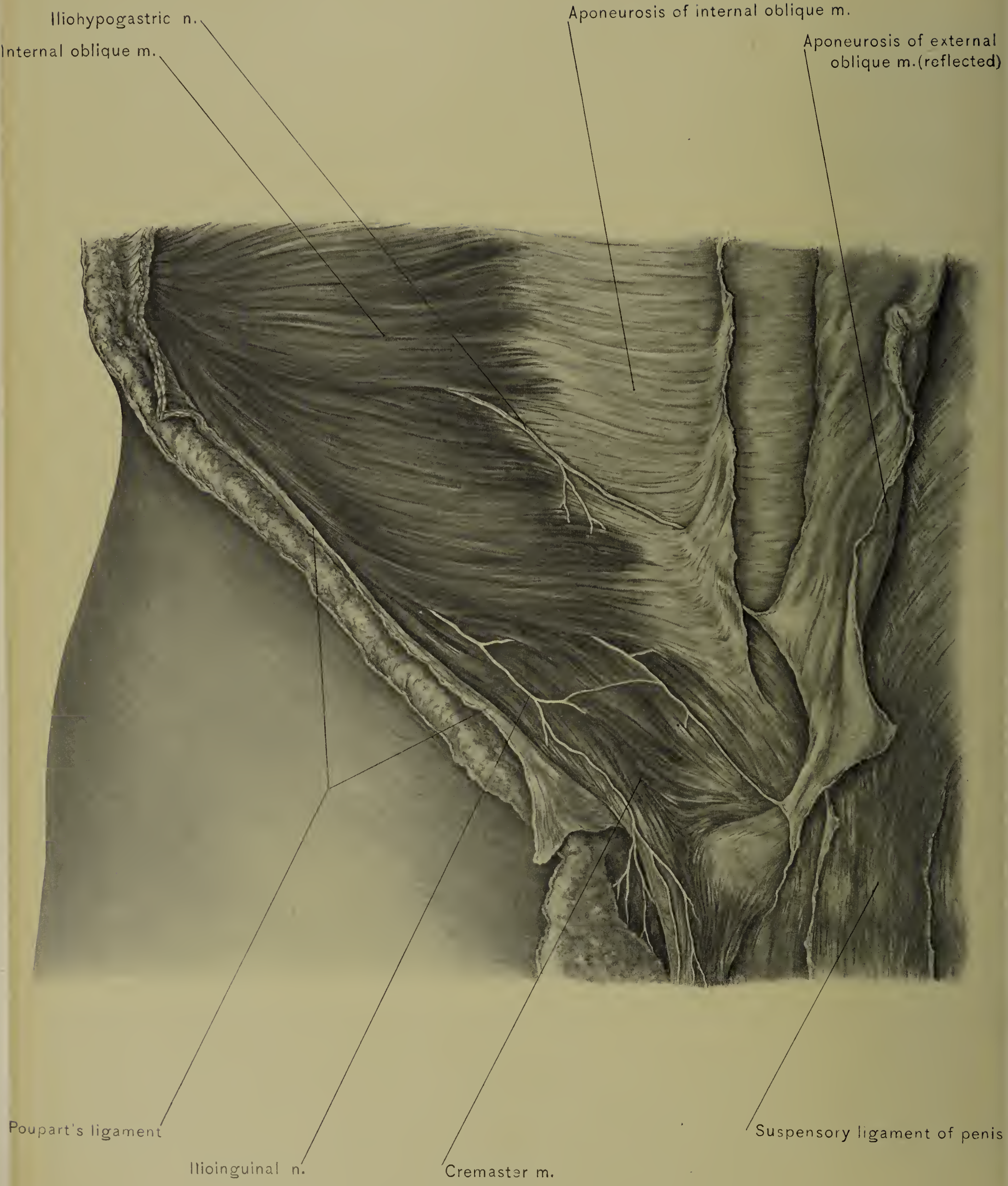
INGUINAL CANAL, CREMASTER MUSCLE, SPERMATIC CORD, AND ILIO-INGUINAL NERVE.



INGUINAL CANAL, CONJOINED TENDON, AND TRIANGULAR LIGAMENT.



INGUINAL CANAL, CONJOINED TENDON, INFUNDIBULIFORM FASCIA.



INGUINAL CANAL, POUPART'S LIGAMENT, SPERMATIC CORD, AND CREMASTER MUSCLE.

nerve, which runs in the cremasteric fascia on the dorsal surface of the cord. Its contents in the female are the round ligament of the uterus, the ilio-inguinal nerve, and the genital branch of the genito-crural nerve.

The **spermatic cord** is the structure which extends from the internal abdominal ring, where its component parts are collected, to the testicle. It is six or seven inches (fifteen to eighteen centimeters) in length, passes through the inguinal canal and the external abdominal ring into the scrotum, to the testicle. As it passes through the external abdominal ring it lies on the outer pillar of the ring. The left spermatic cord is the longer, and therefore allows the left testicle to hang lower than the right one. Its *contents* are the spermatic duct, or vas deferens, the vessels of the vas deferens, the spermatic artery, spermatic veins, or pampiniform plexus, sympathetic nerves, lymphatic vessels, the cord-like remains of the processus vaginalis, the remains of the gubernaculum testis, fat, and connective tissue.

The **spermatic duct** lies behind the other structures of the cord, and gives a cord-like sensation to the finger.

The **spermatic artery and its veins**—the pampiniform plexus—lie in front of the duct. The veins of this plexus are commonly varicose, constituting **varicocele**. These veins have no valves, which partly accounts for their tendency to become varicose. The left plexus of veins is more frequently affected, the reasons given for which are that the left spermatic vein empties into the left renal vein at a right angle, while the right empties at an acute angle into the inferior vena cava; it runs beneath the sigmoid flexure, fecal matter in which compresses it; and that the left vein is the longer of the two.

The sympathetic nerves and the lymphatics accompany the spermatic vessels.

The fat and connective tissue which occupy the interstices between the other constituents of the spermatic cord are continuous with the extraperitoneal fat. Hypertrophy of the fat or lipoma in the spermatic cord (*hernia adiposé*) produces a swelling which simulates an inguinal hernia or a hydrocele of the spermatic cord.

The *coverings of the spermatic cord* are the structures which were carried downward by the processus vaginalis and the testicle in their descent into the scrotum. At the internal abdominal ring the processus vaginalis pushed forward a funnel-shaped process of the transversalis fascia, which is the **infundibuliform fascia, or internal spermatic fascia**; then it took part of the interabdominal fasciæ and a few fibers of the internal oblique, which form the **cremaster muscle, cremasteric fascia, or middle spermatic fascia**; and, finally, in passing through the external abdominal ring, it carried along part of the **intercolumnar fascia, or external spermatic fascia**. Therefore the coverings of the cord in the inguinal

canal are the cremaster muscle or cremasteric fascia, and the infundibuliform fascia; in the scrotum the intercolumnar fascia, cremasteric fascia, and infundibuliform fascia.

The spermatic cord did not, in early fetal life, exist as such, nor did it lie in the inguinal canal until after the descent of the testicle, which carried with it the spermatic vessels and vas deferens, and, in dragging them through a narrow passageway (the internal abdominal ring), brought the duct and vessels together.

Descent of the Testicle and Formation of the Spermatic Cord.—During the early part of intra-uterine life the testicle lies in the abdominal cavity, behind the peritoneum, so that the peritoneum covered its anterior surface and sides, but not the posterior surface. About the third month of fetal life a band which extends from the site of the internal abdominal ring to the testicle and thence upward toward the diaphragm is formed. This constitutes the **gubernaculum testis**. Later in the development of the fetus the peritoneum surrounds the testicle entirely, making a mesentery, or mesorchium, which is composed of two folds, one extending above and the other below the organ. The upper one of these ultimately contains the spermatic vessels, and the lower transmits the gubernaculum testis. The gubernaculum increases in size in its lower part, while the part above the testicle atrophies. At the lower end of this band a tube-like process of peritoneum is formed,—the **processus vaginalis**,—which extends into the inguinal canal. This process of the peritoneum and the gubernaculum gradually descend until they have reached the bottom of the scrotum. After this has taken place, the gubernaculum ceases to grow, and consequently the testicle is drawn downward as the body increases in size. The gubernaculum also atrophies to a certain extent. After the testicle has reached the scrotum, the processus vaginalis atrophies, with the exception of that portion in relation with the testicle which becomes the tunica vaginalis of the testicle. The upper opening of the processus vaginalis is closed, and its thread-like remains can be seen in relation with the spermatic duct as a constituent of the spermatic cord.

Normally the entire canal of the processus vaginalis, except that part in relation with the testicle which forms the tunica vaginalis, closes shortly after the descent of the testicle; but at times this canal fails to close, or is only partially obliterated. As a result of this condition a hernia is likely to occur. This is called a **congenital hernia**—one which occurs because of the presence of a patulous canal. If this pouch of peritoneum (processus vaginalis) remain patulous throughout, the cavity of the processus vaginalis (tunica vaginalis) would be in free communication with the general peritoneal cavity. Under these conditions a hernia may enter the pouch and descend until it is in direct contact with the visceral portion of the tunica vaginalis of the testicle. This constitutes **hernia**



ENCYSTED HERNIA.



INFANTILE HERNIA.



HERNIA INTO THE TUNICA VAGINALIS.



HERNIA INTO THE FUNICULAR PROCESS.

into the tunica vaginalis—a hernia of rapid formation. At times the processus vaginalis will remain patulous down to the external abdominal ring or to a short distance above the testicle, so that a funnel-shaped pouch, or **funicular process**, is formed. A hernia which enters this pouch is known as a **hernia into the funicular process** of the processus vaginalis. If the pouch close only at the internal abdominal ring and remain patulous throughout the rest of its extent, we may find one of two varieties of hernia—infantile or encysted. In the **infantile hernia** the hernial mass pushes against the peritoneum in the vicinity of the internal abdominal ring, forcing it to yield. Thus it forms a sac for itself which descends behind the tunica vaginalis, or processus vaginalis, and, as a result, an infantile hernia presents three coverings of peritoneum in front—the two of the tunica vaginalis and that of the sac. In the **encysted hernia** the protruding mass pushes against the septum, which occludes the processus vaginalis at the internal abdominal ring and forces it to yield. It is, therefore, a hernia of slow formation. Thus the septum forms the sac, which descends within the pouch of the processus vaginalis. The encysted hernia, therefore, presents a sac within a sac, and has two layers of peritoneum in front. The outermost layer is the tunica vaginalis, and the inner layer is formed by the septum which is invaginated into the pouch of the tunica vaginalis.

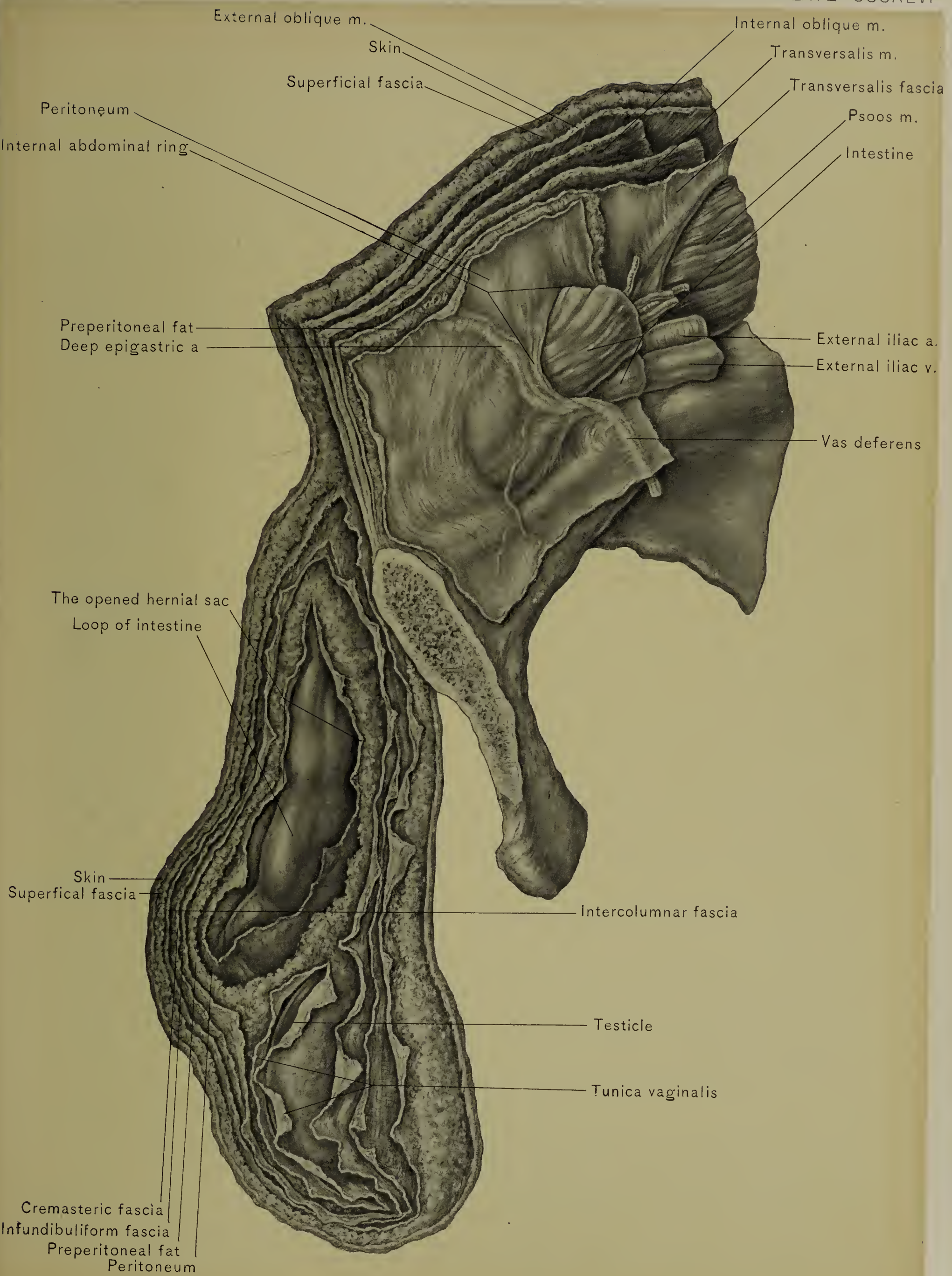
Inguinal hernia.—It will be seen that the direction of the spermatic cord in its passage through the abdominal wall is downward and inward, a little above, and nearly parallel with, the inner one-half of Poupart's ligament. Its constituent parts converge at the internal abdominal ring, which is situated in the transversalis fascia, about a half-inch (1.25 centimeters) above the middle of Poupart's ligament, and pass inward and downward through the inguinal canal and the external abdominal ring, to reach the scrotum. The cord rests in the groove formed by the union of Poupart's ligament and the transversalis fascia. Above it are the arching fibers of the internal oblique and transversalis muscles; in front of it are, from the surface inward, the skin, superficial fascia, and the external oblique aponeurosis along the entire length of the inguinal canal, and the fibers of the internal oblique muscle along the outer third of the canal; behind it are, in the same order, the triangular ligament of the abdominal wall, the conjoined tendon of the internal oblique and transversalis muscles, the transversalis fascia, extraperitoneal areolar tissue or preperitoneal fat, and peritoneum. It should be noticed that the arching fibers of the transversalis muscle do not pass in front of the spermatic cord, but occupy a higher position, and that the arching fibers of the internal oblique cover the upper end of the cord. The latter are the fibers which are divided at their origin in Halsted's operation for the radical cure of oblique inguinal hernia. The boundaries of the inguinal canal and the course,

relations, and coverings of the spermatic cord being understood, the study of inguinal hernia is simplified.

A hernia is an extrusion of a viscus, or part of a viscus, into or through the wall of its containing cavity. Therefore we may have hernia of the brain, lung, intestine, omentum, or other viscera. An extrusion of any of the viscera of the abdominal cavity, or part of them, escaping through either of the abdominal rings is known as an inguinal hernia. A hernia which passes through the internal abdominal ring follows the spermatic cord in an oblique direction, and is therefore known as an *oblique inguinal hernia*; it is called an indirect inguinal hernia because it does not pass perpendicularly through the abdominal wall; it is also called an *external inguinal hernia* because it passes external to the deep epigastric artery. A *direct inguinal hernia* passes directly through the abdominal wall at the position of the external abdominal ring, without having traversed the entire inguinal canal; it is also called an *internal inguinal hernia* because it passes internal to the deep epigastric artery.

Oblique inguinal herniæ are subdivided into those which do not pass beyond the inguinal canal and are called incomplete oblique inguinal herniæ, and into those which pass through the canal and external abdominal ring and are called complete oblique inguinal herniæ. An incomplete oblique inguinal hernia is also called a *bubonocoele*, because it forms a swelling near the common site of buboes.

In an oblique inguinal hernia the extrusion begins by pushing into the internal abdominal ring the depressed portion of the peritoneum in relation with that ring. The depression at this point is called the *hernial fossa of the peritoneum*. This pouch of peritoneum pushes before it the superimposed extraperitoneal areolar tissue (preperitoneal fat) and the infundibuliform process of the transversalis fascia, the whole mass lying in front of the spermatic vessels and duct. Thus far the hernia is covered by peritoneum, subserous areolar tissue, and infundibuliform fascia. As the hernia passes beyond the lower margin of the internal oblique muscle it becomes covered by the cremaster muscle or cremasteric fascia, and as it emerges from the external abdominal ring it carries with it the intercolumnar fascia. Beyond this point, as it descends into the scrotum, it is also covered by the superficial fascia and skin. The *coverings*, therefore, of a complete oblique inguinal hernia, from without inward, are skin, superficial fascia, intercolumnar (external spermatic) fascia, cremaster muscle (cremasteric fascia), infundibuliform (internal spermatic) fascia, preperitoneal fat or extraperitoneal areolar tissue, and peritoneum. The *coverings of an incomplete oblique inguinal hernia*, one which does not pass out of the inguinal canal, are skin, superficial fascia, aponeurosis of the external oblique muscle, cremaster muscle, infundibuliform fascia, preperitoneal fat, and peritoneum.



AN ACQUIRED OBLIQUE INGUINAL HERNIA.

Stricture of the hernial mass may take place at any part of its passage through the belly-wall, at either ring, between them, or in the neck of the sac. If the constriction is at the external abdominal ring, it is remedied by incision of the inner pillar of the opening; if at the internal ring, the obstruction is in one, two, or all three of the innermost three coverings (peritoneum, extraperitoneal areolar tissue, and infundibuliform fascia); if between the two rings, the constriction is in the sac itself. Section of these constrictions should be made in an upward direction. The incision at the internal ring should always be made upward, to avoid division of the deep epigastric vessels.

In a *direct inguinal hernia* the extruding mass passes directly through the belly-wall at the external abdominal ring, through which it emerges. It lies wholly upon the inner side of the deep epigastric artery, and passes through *Hesselbach's triangle*, which is situated in the lower part of the abdominal wall. This triangle is bounded externally by the deep epigastric artery; internally, by the outer margin of the rectus abdominis muscle; and below, by Poupart's ligament. The abdominal wall at the inner two-thirds of this triangle is strengthened by the conjoined tendon, while at the outer third it is much weaker, because of the absence of muscular and tendinous tissues in the interval between Poupart's ligament and the arching fibers of the internal oblique and transversalis muscles. This outer corner of Hesselbach's triangle may appropriately be called the *weak angle* of the triangle, as it is devoid of the protection of the conjoined tendon and contains no substitute for it. Through this weak angle a direct inguinal hernia may pass into the inguinal canal and be covered by the cremasteric and intercolumnar fasciæ, the same as an oblique inguinal hernia; all coverings of such a direct inguinal hernia would be the same as in a complete oblique inguinal hernia, except that the general transversalis fascia is substituted for the infundibuliform fascia.

At other times the protrusion either passes between the fibers of the conjoined tendon, or pushes this structure before it as one of its coverings, which are the same as those of a complete oblique inguinal hernia, except that the conjoined tendon takes the place of the cremaster muscle, and the general transversalis fascia that of its infundibuliform process. Therefore the coverings of a direct inguinal hernia are skin, superficial fascia, intercolumnar fascia, conjoined tendon, transversalis fascia, preperitoneal fat, and peritoneum.

Stricture of a direct inguinal hernia is most likely to occur at the external abdominal ring. It may be situated in the edges of the separated conjoined tendon if the gut has passed through it. It is relieved by upward section, thus avoiding the deep epigastric artery.

The relation of the direct and indirect inguinal herniæ to the spermatic cord

differs. The contents of the cord are spread over the posterior surface and sides of the sac of an oblique inguinal hernia, whereas the cord and its two inner coats lie behind and external to a direct inguinal hernia.

Inguino-crural hernia is the name given to an inguinal hernia which, for some reason, as obstruction by a partially descended testicle, does not pass into the scrotum, but, after passing through the external abdominal ring, turns outward along Poupart's ligament.

Intraparietal herniæ, which include **preperitoneal** and **intermuscular herniæ**, are those in which the sac dissects one or more of the layers of the abdominal wall.

The reduction of herniæ by taxis requires, previous to manipulation, a maximum amount of relaxation of the parts involved. This is best effected by laying the patient upon the back, with the head and shoulders well raised and the thigh of the affected side flexed and adducted, thus relieving the tension caused by the fascia lata of the thigh and the aponeurosis of the external oblique muscle. The hips also are elevated so that gravity may aid in reducing the hernia. The hernial mass should be slightly drawn downward, so as to obliterate folds or overlapping at the constriction; in front of the point of constriction the mass must be held so as to avoid local bulging; gentle pressure is then made toward the abdomen in the line of the hernia. In reduction of an oblique inguinal hernia pressure is directed upward, outward, and backward; the direction of the pressure upon a direct hernia is backward.

An oblique inguinal hernia will in time drag the internal abdominal ring almost opposite to the external abdominal ring, so that in reduction it takes nearly the same course as a direct inguinal hernia. This is due to the long-continued traction of the extruded hernial mass tending to bring the abdominal rings one directly behind the other, the external ring enlarging externally and the internal ring internally. Such an old indirect hernia is called a **straight hernia**, and is always distinguishable from a direct hernia by the presence of the deep epigastric artery upon its inner side.

In the female a congenital oblique inguinal hernia may enter the canal of Nuck. An incomplete oblique inguinal hernia, or bubonocoele, is the same in both sexes, having the same relations and the same coverings. The scrotal hernia of the male corresponds to the **labial hernia** of the female. These herniæ have the same coverings as in the male, except that there will be no counterpart of the cremaster muscle.

Operations for inguinal hernia.—The incision should be made over the hernial mass and parallel with its long axis. It passes through the different coverings of the various herniæ, these differing but little, as will be seen by a reference

to the anatomic coverings of the several varieties. It must be borne in mind that the deep epigastric artery lies to the inner (median) side of the neck of an indirect inguinal hernia, and to the outer side of that of a direct inguinal hernia. In operating upon an *incomplete indirect inguinal hernia* the incision will sever the skin, the superficial fascia, the superficial epigastric vessels, and the aponeurosis of the external oblique muscle; the ilio-inguinal nerve is displaced outward, and the cremasteric fascia, the infundibuliform fascia, and the preperitoneal fat are divided to expose the hernial sac. In operating upon a *complete oblique inguinal hernia* the skin, superficial fascia, superficial epigastric and superficial external pudic vessels, intercolumnar fascia, and aponeurosis of the external oblique muscle are divided, the ilio-inguinal nerve is displaced outward, and the cremaster muscle, infundibuliform fascia, and preperitoneal fat are divided to expose the hernial sac. In operating upon a *direct inguinal hernia* the incision severs the skin, the superficial fascia, the superficial external pudic vessels, the intercolumnar fascia, the aponeurosis of the external oblique muscle, the conjoined tendon (only when the hernia is strangulated), the transversalis fascia, and the preperitoneal fat to expose the hernial sac. At times a direct hernia escapes around the outer side of the conjoined tendon, the structures lying over it, under these conditions, being the same as those found in a complete indirect inguinal hernia, with the exception that a portion of the transversalis fascia instead of the infundibuliform fascia forms a covering for such a direct hernia. Although in each case these layers of tissue cover the hernia, they are not always readily recognized separately.

In a hernia due to congenital defects, the structures severed are practically the same as in the acquired forms, with the exception of the difference in the number of layers of peritoneum found overlying each. In a hernia into the processus vaginalis or into its funicular process there is but one layer of peritoneum in front of the gut. In an infantile hernia the sac descends behind the unobliterated portion of the processus vaginalis, so that there are three layers of peritoneum in front of the hernia. In an encysted hernia the sac descends within the processus vaginalis and has two distinct sacs, one being within the other, a single and a double layer of serous membrane lying in front of the gut.

The relation of the hernial mass to the spermatic cord must be remembered. The constituents of the spermatic cord are usually spread over the posterior and lateral aspects of the sac of the hernia.

In relieving the constriction in a strangulated indirect inguinal hernia the nick in the constriction should be made upward and outward, in order to avoid the deep epigastric artery, and in a direct inguinal hernia, upward and inward for the same reason. It is generally safer, however, to relieve the constriction by an upward incision in both cases, as it is, at times, most difficult to make a diagnosis

between an indirect inguinal hernia of long standing and a direct inguinal hernia, because the indirect hernia, if large or of prolonged duration, tends to bring the two abdominal rings nearly opposite. If the incision be made upward in relieving the constriction, there is no danger of wounding the artery.

Having opened the sac in a strangulated hernia, the constriction should be relieved at once, the bowel being then examined before returning it to the abdominal cavity, in order to determine whether its blood supply will return and the gut regain its normal condition. In order to favor return of the circulation in the discolored bowel traction should be made on the loop of gut until from two to three inches (five to seven centimeters) of healthy bowel are drawn into the wound at both ends of the loop. If it fail to show signs of recovery after treatment with hot, moist sterile gauze and gangrene is likely to occur, it is advisable either to do a resection and anastomosis, or to fix the gut in the wound with a view to establishing an artificial anus after the gangrenous portion of the intestine shall have separated. The latter should be done only when the patient is *in extremis*. After resection of the gangrenous bowel the author does end-to-end anastomosis with needle and thread. In no case is it permissible to return the hernia *en masse*. If there be any signs of gangrene in the omental contents of the hernial mass all such portions should be tied off and removed.

In operation upon either a reducible or a strangulated hernia the sac should be separated from the spermatic cord, and the hernial openings and canal treated by one of the various radical operations advanced for the permanent cure of the defect.

In the open operations for the radical cure of oblique inguinal hernia described below, excepting MacEwen's operation, the same structures are divided in exposing the sac. These are the skin, superficial fascia, superficial epigastric and superficial external pudic vessels, aponeurosis of the external oblique muscle, intercolumnar fascia, cremaster muscle, infundibuliform fascia, and preperitoneal fat.

In *MacEwen's operation* the hernial contents are reduced and the sac is separated from the constituents of the spermatic cord without dividing the anterior wall of the inguinal canal. The hernial contents having been reduced and the sac freed from the surrounding structures, a running stitch is passed through the sac several times, so that when drawn tight, it folds or puckers it. This pad of tissue is next fixed in the internal abdominal ring by passing the suture through the transversalis fascia and abdominal muscles above the ring, and tying down upon the aponeurosis of the external oblique muscle. This forms a pad at the internal ring and produces an elevation at the position occupied by the "hernial fossa" of the peritoneum. A series of sutures is then passed across the canal in

front of the cord, uniting the conjoined tendon and arching fibers of the internal oblique and transversalis muscles to Poupart's ligament.

Bassini's Operation.—The anterior wall of the inguinal canal, excepting the lower fibers of the internal oblique muscle, is divided, the sac is freed from the surrounding structures, tied off at the neck, and the portion in front of the ligature is removed. The spermatic cord is then lifted up and the sutures are carried under it, by which the border of the rectus abdominis muscle, the conjoined tendon, the arching fibers of the internal oblique and transversalis muscles, and the transversalis fascia are fastened to the posterior shelving margin of Poupart's ligament. The cord is then placed upon the arching fibers of the internal oblique and transversalis muscles and the conjoined tendon, and the wound in the aponeurosis of the external oblique muscle is closed over the cord. In this way the inguinal canal is entirely obliterated, and a new passageway is formed for the spermatic cord. The skin and superficial fascia are then closed as usual.

The operation which the author prefers is a combination of MacEwen's and Bassini's. The anterior wall of the inguinal canal, excepting the lower fibers of the internal oblique muscle, is divided, and the sac freed and repositioned at the internal abdominal ring, after the manner of MacEwen. The canal is closed as in Bassini's operation.

Umbilical Herniæ are of three varieties—viz., the congenital, the infantile, and the acquired.

A **congenital umbilical hernia** is present at birth, occurs more frequently in females, and is due to a defect in the anterior abdominal wall—failure of the two somatopleuræ to unite. The hernia may be of large size, and may contain not only intestine, but the spleen, liver, and other organs, or it may be small, appearing as a tumor at the root of the umbilical cord, between the structures of which the sac protrudes. Before ligating the umbilical cord, and particularly if it be at all bulky, it should be examined carefully for fear of including in the ligature the contents of such a hernia. The coverings of this variety of hernia are the structures of the umbilical cord.

An **infantile umbilical hernia** appears after detachment of the umbilical cord, and is due to yielding of the umbilical cicatrix. It is generally small, and the tendency is toward a spontaneous cure. The coverings of this variety are skin, superficial fascia, transversalis fascia, preperitoneal fat, and peritoneum.

An **acquired umbilical hernia** most commonly develops in adults, and does not always occur through the umbilicus, sometimes passing through the linea alba above, below, or to one side of the umbilicus. When the hernia takes place through the umbilicus, it is usually at the upper part, above the urachus and obliterated hypogastric arteries, which is the weakest part of the scar. Acquired

umbilical hernia occurs most frequently in women who have borne children and whose abdominal walls are more or less pendulous from deposit of fat. These herniæ may be quite small, but often are of considerable size. The skin covering a large umbilical hernia is frequently ulcerated, from interference with its circulation by pressure of the contents. The contents are the great omentum and small intestine, and frequently a loop of the transverse colon. They are usually irreducible, on account of the presence of adhesions. The coverings of this variety of hernia are, theoretically, skin, superficial fascia, transversalis fascia, preperitoneal fat, and peritoneum, but, practically, they are skin, connective tissue, and peritoneum, the layers beneath the skin becoming fused into one layer with the peritoneum.

Radical cure of umbilical hernia.—In the operation for the radical cure of long-standing acquired umbilical hernia it is more difficult to free the sac than in either inguinal or femoral herniæ. The operation in this variety of hernia differs from that done in either of the two last-named forms in that the sac is not dissected free except at its neck, which is exposed by carrying an elliptic incision through the integument and fascia overlying this portion of the hernia. The neck of the sac having been exposed, it is separated from the margins of the opening. The sac is next laid open, and the contents, if not already reducible, are rendered so. After the gut and omentum are reduced, the whole of the sac with the overlying integument is cut away. The wound now is similar to that made in opening the abdomen through the middle line, except that the umbilicus is cut out. The wound may be closed by interrupted sutures, including all the layers of the belly-wall, or by tiers of sutures, all of which are buried, except the tier that closes the wound in the skin and superficial fascia. The skin and superficial fascia may be apposed by the subcuticular stitch.

The operation which the author prefers is somewhat different from that described. The sac is disposed of as previously described. The recti muscles are exposed by incising the anterior walls of their sheaths near the linea alba on each side of the wound, and are then brought together by sutures which are passed through them and the anterior walls of their sheaths from within outward.

Operation for acquired umbilical hernia does not give so satisfactory results as does that for either the inguinal or the femoral variety, owing to the great strain to which the thin central part of the abdominal wall is subjected. The foregoing operation is also applicable to either the congenital or the infantile variety.

Umbilical herniæ, when strangulated, are not so favorable cases as are the other common forms of hernia, because the part of the intestine involved—viz., the jejunum—is more essential for the function of digestion. While operation at

the earliest possible moment is required in any case of strangulated hernia, it is especially so in the umbilical form.

NERVE SUPPLY.—The nerve supply of the abdominal wall is derived from the lower seven intercostal nerves and the ilio-hypogastric and ilio-inguinal branches of the anterior division of the first lumbar nerve. As these nerves supply both the skin and the muscles of the anterior and lateral wall of the abdomen, irritation of the skin of the belly causes contraction of the muscles of the belly-wall. This is one reason for palpation of the abdomen with the whole of the palm of the hand, rather than with the tips of the fingers, and for palpation with warm hands, as sudden pressure with the tips of the fingers or contact with cold causes irritation of the cutaneous nerve-fibers and contraction of the muscles. After a few moments the nerves become accustomed to the pressure of the hand, the muscles relax, and the abdominal organs can be palpated.

The violent respiratory effort or gasp after contact of the chest or abdomen with cold, as in a cold bath, occurs because the cutaneous nerves of the anterior and lateral portions of the chest and abdomen are supplied by the intercostal nerves, which also supply the intercostal muscles. In caries of the lower thoracic vertebræ and in locomotor ataxia irritation of the nerves may cause pain in the abdomen and girdle sensations, which are compared to constriction of the abdomen with a cord. The pains referred to the abdominal wall in locomotor ataxia produce the **gastric crises** of that disease.

The close connection between the nerve supply of the anterior and lateral abdominal wall and that of the abdominal viscera explains some peculiar instances of referred irritation causing pain and spasm. The abdominal viscera and the peritoneum are supplied by branches derived from the solar plexus, which receives fibers from the splanchnic nerves. These nerves arise from the fifth to the twelfth thoracic ganglia of the sympathetic nerve cord inclusive, and these ganglia are connected with the lower thoracic nerves by the rami communicantes. The lower intercostal nerves, which are branches of the anterior divisions of the lower thoracic nerves, supply both the muscles and integument of the upper three-fourths of the anterior and lateral abdominal wall. In peritonitis or irritation of the peritoneum or viscera, as in appendicitis, irritation reflected along the nerves causes spasm and rigidity of the muscle of the belly-wall, and pain which, in the earlier stages of the disease, is usually referred to the epigastric and umbilical region. In peritonitis the reflex irritability of these nerves is so great that slight pressure which could not disturb the inflamed peritoneum, except through resulting contraction of the flat muscles of the abdominal wall, causes such intense pain that it is necessary to prevent the bed-clothing from resting upon the abdomen.

The direction of the nerves in the abdominal wall is sometimes considered in making incisions; these nerves run, in a general way, obliquely, from behind forward and downward. A vertical incision of considerable length through the abdominal wall at or external to the linea semilunaris would divide several of the intercostal nerves and the muscles supplied by them—for instance, the segments of the rectus abdominis would be paralyzed and thus, of course, rendered less able to resist intra-abdominal pressure.

Wounds of the Abdominal Wall which extend through the external oblique muscle or aponeurosis and perhaps involve the other two flat muscles are likely to gape, and the underlying muscle, fascia, peritoneum, or abdominal viscera protrude. Fragments of glass, wood, or steel may be concealed in the intermuscular connective-tissue planes and not be found. The connective-tissue planes also favor the retention of pus and extension of abscess, should suppuration occur. Frequent contraction of the muscles retards healing of the wound if the patient be not kept in bed.

If the wound penetrate the abdominal cavity, contraction of the muscles of the abdominal wall may cause protrusion of a portion of one or more viscera; in reducing the protruding viscus, a portion may be pushed into one of the intermuscular planes or into the preperitoneal fat. In introducing sutures to close the wound, all the layers divided must be included. Failure to include the peritoneum may be a cause of subsequent hernia.

DISSECTION.—In reflecting the transversalis muscle the portion of the transversalis fascia lining that muscle has probably been removed with the muscle. The remaining portion of the transversalis fascia is likely to be that part which closes the gap between Poupart's ligament and the arching fibers of the transversalis muscle.

The **Extraperitoneal Connective Tissue** (subperitoneal or preperitoneal fat) is seen after removal of the transversalis fascia. It is composed of loose areolar tissue and fat, attaches the rough external surface of the peritoneum to the walls of the abdominal cavity and the viscera in relation with the peritoneum, and transmits the blood-vessels of the abdomen. It is thickest at the sides of the upper lumbar vertebræ, where it invests the kidneys, forming a soft, elastic bed for them. It is continuous with the fibrous coats of the abdominal viscera and the true sheaths of the blood-vessels of the abdomen. It extends into the spermatic cord, within the tube formed by the infundibuliform fascia. There it is found as the areolar tissue of the spermatic cord, which invests the spermatic vessels, nerves, lymphatics, and ducts, and may contain an excess of fat, thus forming a swelling (*hernia adiposé*) which may resemble an oblique inguinal hernia. It also extends into the femoral canal or inner compartment of the femoral sheath. The part of the extraperitoneal

connective tissue which fills the femoral ring is called the **septum crurale**. Processes of the extraperitoneal fat at times protrude through openings in the aponeurosis at the linea alba, and form button-like tumors which resemble omental herniæ.

In the extraperitoneal connective tissue the blood-vessels of the viscera anastomose with those of the abdominal wall. Through these anastomoses cupping and leeching of the surface of the abdomen may influence active congestion of the viscera.

Like the peritoneum, the extraperitoneal connective tissue is divided into a parietal portion and a visceral portion.

The laxity of the extraperitoneal connective tissue favors stretching of the peritoneum, as in herniæ and in certain extraperitoneal operations, as in extraperitoneal ligation of the external iliac artery and in operations upon the kidney through the loin in which extensive areas of the peritoneum are displaced by tearing the extraperitoneal connective tissue.

The **parietal portion** connects the parietal portion of the peritoneum with the various fasciæ—diaphragmatic, transversalis, lumbar, iliac, pelvic, and recto-vesical—which line the muscular walls of the abdominal cavity. This portion is best developed at the sides of the lumbar vertebræ, where it forms the **perirenal fat**.

The **visceral portion** extends between the folds of the peritoneum, such as the mesentery, transmits the blood-vessels, lymphatic vessels, and nerves to the viscera, and assists largely in retaining the abdominal organs in their various positions. Through this portion abscesses arising from the viscera reach the parietal portion of the extraperitoneal connective tissue, in which, as this tissue is lax and offers but slight resistance, they burrow extensively. This is notably true of abscesses produced by appendicitis. These abscesses may burrow from one side of the abdomen to the other, or from one end of the abdomen to the other, and be evacuated above by way of the thorax and respiratory tract, or below by way of the rectum.

DISSECTION.—The deep circumflex iliac and deep epigastric arteries can now be traced through the extraperitoneal connective tissue to their origin, and their accompanying veins can be followed to their termination in the external iliac vein. These arteries and their venæ comites have been previously described.

Hesselbach's Triangle can now be observed. It is an important guide, as it assists us in remembering that the neck of the sac of a direct inguinal hernia is situated on the inner side of the deep epigastric artery. The triangle is bounded externally by the deep epigastric artery, internally by the outer border of the rectus muscle, and below by Poupart's ligament. All direct inguinal herniæ pass through it.

DISSECTION OF THE ABDOMINAL CAVITY.

DISSECTION.—To expose the cavity of the abdomen and its contents an incision should be made from the ensiform cartilage to the os pubis, keeping slightly to the left of the linea alba and umbilicus, thus avoiding cutting the round ligament of the liver (ligamentum teres), which extends from the umbilicus to the longitudinal fissure of the liver, and the urachus, which extends from the summit of the bladder to the umbilicus. A second incision should be carried through the umbilicus, and transversely outward as far as the outer edge of the quadratus lumborum muscle. The four flaps thus formed should then be turned outward. When the abdomen has been opened in this manner the anterior parietal peritoneum has been divided in making the incisions.

Before studying the exposed abdominal viscera *in situ*, the round ligament of the liver, the urachus, the obliterated hypogastric arteries, and the inguinal fossæ should be examined.

The **Round Ligament of the Liver** is the obliterated umbilical vein, whose function in the fetus it is to carry oxygenated blood from the placenta. It lies in the umbilical portion of the longitudinal fissure of the liver, and between the liver and umbilicus it is situated in the free margin of the longitudinal, falciform, or suspensory ligament of the liver and between its two layers.

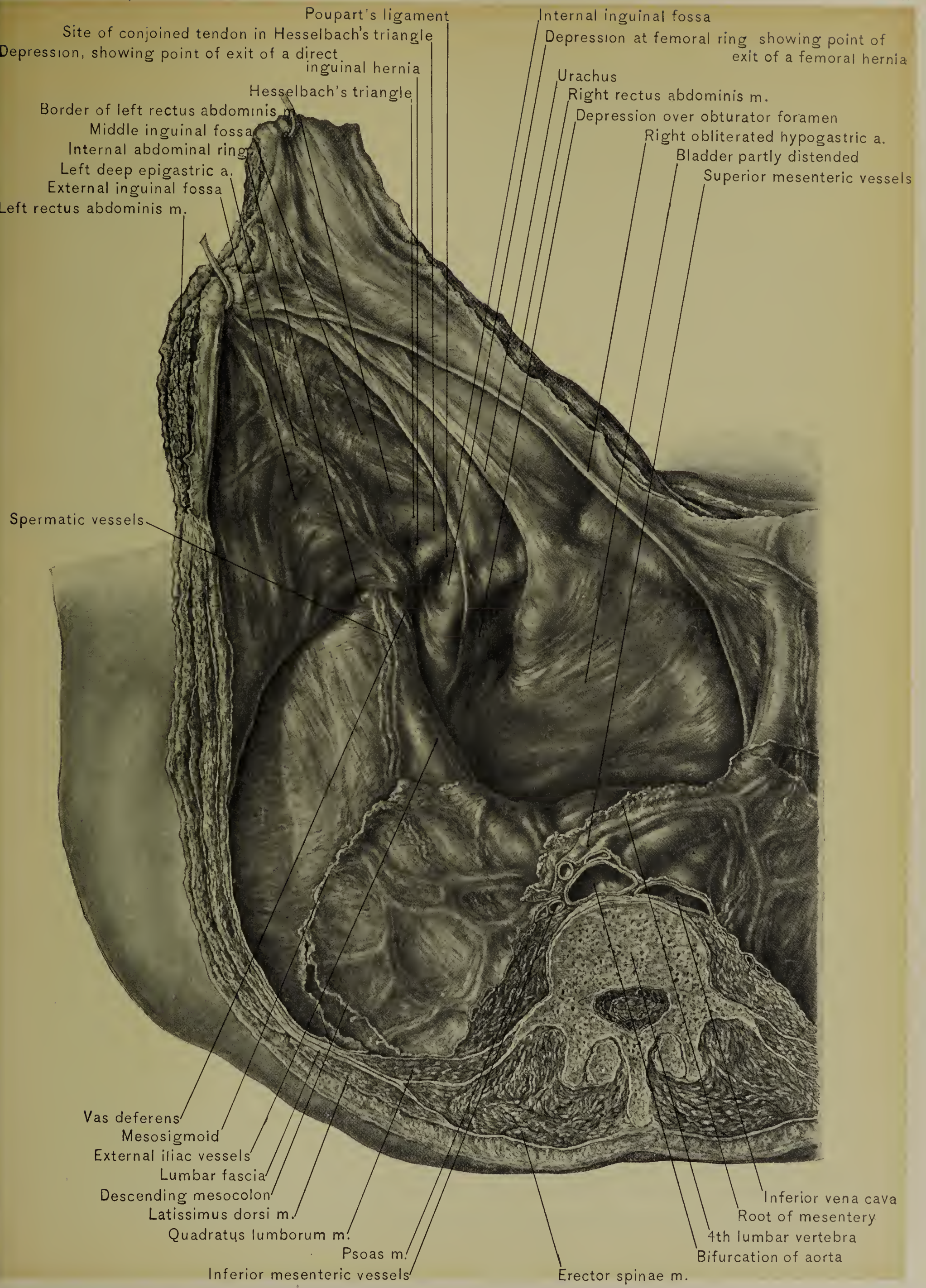
The **Urachus** extends from the summit of the bladder to the umbilicus, and is a remnant of the allantoic stalk. It sometimes remains patulous, and then causes an **umbilical urinary fistula**. **Cysts of the urachus** may be mistaken for ovarian cysts.

The **Hypogastric Arteries** are two cords which form a ridge upon each side of the urachus, extending from the side of the summit of the bladder to the umbilicus. These are the obliterated hypogastric arteries, and it is their function in the fetus to return the venous blood to the placenta. They also pass downward along the sides of the bladder, to join the superior vesical arteries. Hemorrhage from these arteries may occur in the infant when the stump of the umbilical cord becomes detached.

The **Inguinal Fossæ** are three depressions in the internal surface of the peritoneum, situated on the internal surface of the abdominal wall, just above Poupart's ligament.

The **external inguinal fossa** is small, and lies external to the deep epigastric artery. In this location the peritoneum presents a small depression, which is situated at the position of the internal abdominal ring, and is known as the hernial fossa of the peritoneum. Through this fossa an oblique inguinal hernia passes.

The **middle inguinal fossa** is bounded internally by the obliterated hypogas-



INGUINAL FOSSÆ.

tric artery; externally, by the deep epigastric artery; and below, by Poupart's ligament. Quite a large pouch is frequently found leading from this fossa downward and inward, behind the obliterated hypogastric artery.

The **internal inguinal fossa** is bounded externally by the obliterated hypogastric artery, internally by the urachus, and below, by the bladder. A direct inguinal hernia passes through either the middle or the internal inguinal fossa.

The abdominal cavity having been opened, the following viscera can be seen by removing merely the anterior abdominal walls and reflecting the anterior parietal peritoneum; sometimes, however, a larger portion of one organ or a smaller portion of another may be seen, varying with the amount of distention, hypertrophy, collapse, or atrophy of the organs, or with the degree of compression of the lower part of the thorax by corsets: The liver occupies the right hypochondriac, the epigastric, and sometimes extends into the left hypochondriac region as far as the left mammillary line. Its right lobe projects slightly below the costal margin. The quadrate lobe and the left lobe extend downward at the subcostal angle to a line from the ninth costal cartilage on the right side, to the eighth cartilage on the left side. The gall-bladder is on the under surface of the right lobe of the liver, and its fundus is opposite the intersection of the outer margin of the right rectus muscle with the costal margin or the lower margin of the ninth costal cartilage. In the left hypochondriac and in the epigastric region a part of the stomach is seen extending below the left lobe of the liver and the ribs, the size of the portion that is visible depending on the degree of distention. Descending from the stomach and extending beyond the umbilical region is the great omentum, a broad fold of peritoneum which reaches to the pelvis, covers the small intestine, and contains more or less fat; in some cases the great omentum is so small and shrunken as to be barely visible, thus leaving the small intestine uncovered. If the great omentum is absent, the small intestine will be seen immediately occupying the lower part of the abdomen and part of the pelvis. If the bladder is distended, a small part of it will be seen just above the pubes. In the right iliac fossa is the cecum, or head of the colon. If the appendix is situated anteriorly to the cecum,—one of its unusual positions,—it also will be seen without disturbing the viscera. The ascending colon in the right, and the descending colon in the left, lumbar region are usually found contracted and lying at the back of the abdomen, and are, therefore, not to be seen upon superficial inspection if not much distended. The transverse colon can usually be seen crossing the abdomen just below the stomach and above the small intestine.

The **abdominal cavity** is the largest cavity in the body, the next in size being the thoracic cavity. These two cavities originally formed the pleuro-peritoneal cavity of the embryo, which was subdivided by the development of the diaphragm.

It is bounded in front and laterally by the lower ribs, the flat muscles of the abdominal wall, and the transversalis fascia; behind, by the bodies of the lumbar and sacral vertebræ, the ilium, the iliac and lumbar fasciæ, and the psoas, iliacus, and quadratus lumborum muscles; above, by the diaphragm and diaphragmatic fascia; and below, by the tissues which fill the outlet of the pelvis.

Contents.—The abdominal cavity contains all that part of the alimentary canal intervening between the terminal part of the esophagus and the anus, the liver, spleen, kidneys, suprarenal capsules, pancreas, many blood-vessels, lymphatic vessels, lymphatic glands, and nerves. It also contains the peritoneum, which facilitates movement of the viscera. The size of the cavity is influenced by the varying conditions of its boundaries. Its depth is lessened by contraction and descent of the diaphragm, and by contraction and ascent of the levatores ani and coccygei muscles; its width is diminished by contraction of the muscles of the anterior and lateral walls of the abdomen.

Owing to the conformation of the viscera to one another and the presence of the extraperitoneal fat and a small quantity of serum in the peritoneal cavity, there are no vacant spaces in the abdominal cavity. The gas in the stomach and intestine and the tonic state of contraction of the muscles in the walls of the abdomen produce a varying degree of *intra-abdominal pressure*. In punctured wounds of the intestine the intra-abdominal pressure is believed to be a more important factor in preventing escape of feces in the peritoneal cavity than hernial protrusion of the mucous membrane of the bowel. The cure or temporary improvement following exploratory abdominal sections is believed to be due to some influence exercised upon the vessels and nerves of the diseased tissues by disturbance of the intra-abdominal pressure.

The abdominal cavity is composed of two divisions—the abdominal cavity proper, extending between the diaphragm above and the ilio-pectineal lines below; and the pelvic cavity, the portion below the ilio-pectineal lines. The former may be said to consist of an upper portion, which is above the level of the crests of the ilia, and of a lower portion, the false pelvis, which is between the level of the crests of the ilia and that of the ilio-pectineal lines.

The abdominal cavity proper is bounded above by the diaphragm and the diaphragmatic fascia; below, by the ilio-pectineal lines; in front and on the sides, by the lower ribs, the flat muscles of the anterior abdominal wall, the ilia, and the transversalis fascia; and behind, by the spinal column, the quadratus lumborum, psoas, and iliacus muscles, and the lumbar, psoas, and iliac fasciæ. The pelvic cavity is bounded above by the ilio-pectineal lines; below, by the tissues filling in the outlet of the pelvis—viz., the recto-vesical fascia, the levatores ani and coccygei muscles, the anal fascia, and the triangular ligament of the peri-

neum ; in front and at the sides, by the pelvic fascia, which covers the pubic bones, ischia, and obturator internus muscles ; and behind, by the pelvic fascia, the pyri-formes muscles, the sacrum, the coccyx, and the great sacro-sciatic ligaments.

The **Openings in the Walls of the Abdomen** for the passage of structures to and from the abdominal cavity proper are : The umbilicus, which, in the fetus, transmits the umbilical vessels—the umbilical vein and the two hypogastric arteries ; the quadrate opening in the diaphragm, which gives passage to the inferior vena cava ; the aortic opening in the diaphragm, through which pass the aorta, the vena azygos major, and the thoracic duct ; the esophageal opening in the diaphragm, through which pass the esophagus and pneumogastric nerves ; two internal abdominal rings, which are situated on each side in the transversalis fascia about one-half inch (one to two centimeters) above, and slightly external to, the middle of Poupart's ligament ; and the space beneath Poupart's ligament.

The internal abdominal ring in the male gives passage to the spermatic duct, the spermatic vessels, the artery of the vas deferens, the remains of the processus vaginalis, the sympathetic nerves, the lymphatic vessels, the cremasteric artery, and the genital branch of the genito-crural nerve ; in the female it transmits the round ligament and the genital branch of the genito-crural nerve. The space beneath Poupart's ligament, or the crural arch, gives passage to the common femoral vessels, the anterior crural nerve, the crural branch of the genito-crural nerve, the external cutaneous nerve, the psoas and iliacus muscles, and, sometimes, the accessory obturator nerve.

Regions of the Abdomen.—For convenience in locating its contained organs, the general abdominal cavity is divided into nine regions by planes located by lines drawn on the surface of the body. Although these lines have been drawn in various ways, the following method seems to be the most desirable. Two transverse circular lines are drawn around the body. One passes through the lowest point on the inferior costal border, which is usually the lower margin of the eleventh costal cartilage and sometimes of the tenth costal cartilage ; and the other through the anterior superior spines of the ilia. Thus the abdominal cavity is divided into three segments. These are each subdivided into three parts by two planes passing through two lines which are drawn over the vertical portions of the outer borders of the two rectus muscles ; these lines correspond practically to lines drawn vertically upward from the middle of Poupart's ligament. The three regions in the median line, named from above downward, are the epigastric, umbilical, and hypogastric regions. The three regions on each side, named in the same order, are the hypochondriac, lumbar, and iliac regions.

The following table shows the viscera that are found in each region. It should be remembered that the positions of the abdominal viscera not only vary

slightly in different individuals, but that these organs change their positions and relations somewhat with almost every movement of the body. Although the localization of the abdominal viscera, as stated below, can be only approximate, it is of great value in physical diagnosis.

RIGHT HYPOCHONDRIAC.	EPIGASTRIC.	LEFT HYPOCHONDRIAC.
Liver (part of right lobe).	Liver (left lobe, quadrate, caudate, and Spigelian lobes).	Liver (small portion of left lobe occasionally).
Gall-bladder (divided by the longitudinal line).	Gall-bladder (divided by the longitudinal line).	Spleen.
Kidney (upper and outer parts).	Stomach (pyloric and middle portions with the cardiac and pyloric orifices).	Pancreas (tail).
Colon (hepatic flexure and part of ascending colon).	Intestine (first, second, and fourth portions, and the termination of the third portion of duodenum and part of the transverse colon).	Kidney (upper and outer parts).
	Pancreas (head and body).	Stomach (cardiac end).
	Kidneys (upper and inner parts, with sinus and pelvis of the ureters).	Colon (splenic flexure and part of descending colon).
	Suprarenal bodies.	
	Spleen (upper and inner parts).	
Upper transverse plane at level of lowest point in costal border.		
RIGHT LUMBAR.	UMBILICAL.	LEFT LUMBAR.
Kidney (lower and outer parts).	Kidneys (lower and inner portion).	Kidney (lower and outer parts).
Intestine (ascending colon, part or all of cecum, and part or all of the vermiform appendix. Some small intestine, mostly ileum).	Ureters.	Intestine (small intestine, mostly jejunum; descending colon and part of the sigmoid flexure).
	Intestines (lowest part of third portion of duodenum; part of jejunum, ileum, and transverse colon; and, usually, part of the sigmoid flexure).	
	Uterus in pregnancy.	
Lower transverse plane through anterior superior spines of ilia.		
RIGHT ILIAC.	HYPOGASTRIC.	LEFT ILIAC.
Intestine (small intestine, mostly ileum; sometimes the tip of the cecum and part or all of the vermiform appendix).	Intestine (jejunum and ileum of small intestine, and part of the sigmoid flexure).	Intestine (small intestine and part of the sigmoid flexure).
	Ureters.	
	Bladder (in children and, when distended, in adults).	
	Uterus in pregnancy.	

The **Peritoneum** is the serous membrane which lines the walls of the abdominal cavity, and covers more or less completely the viscera within that cavity, as well as the processes of the extraperitoneal connective tissue that transmit the vessels and nerves to the viscera. Its inner surface is smooth and glossy, and its outer surface rough and attached to the abdominal walls and

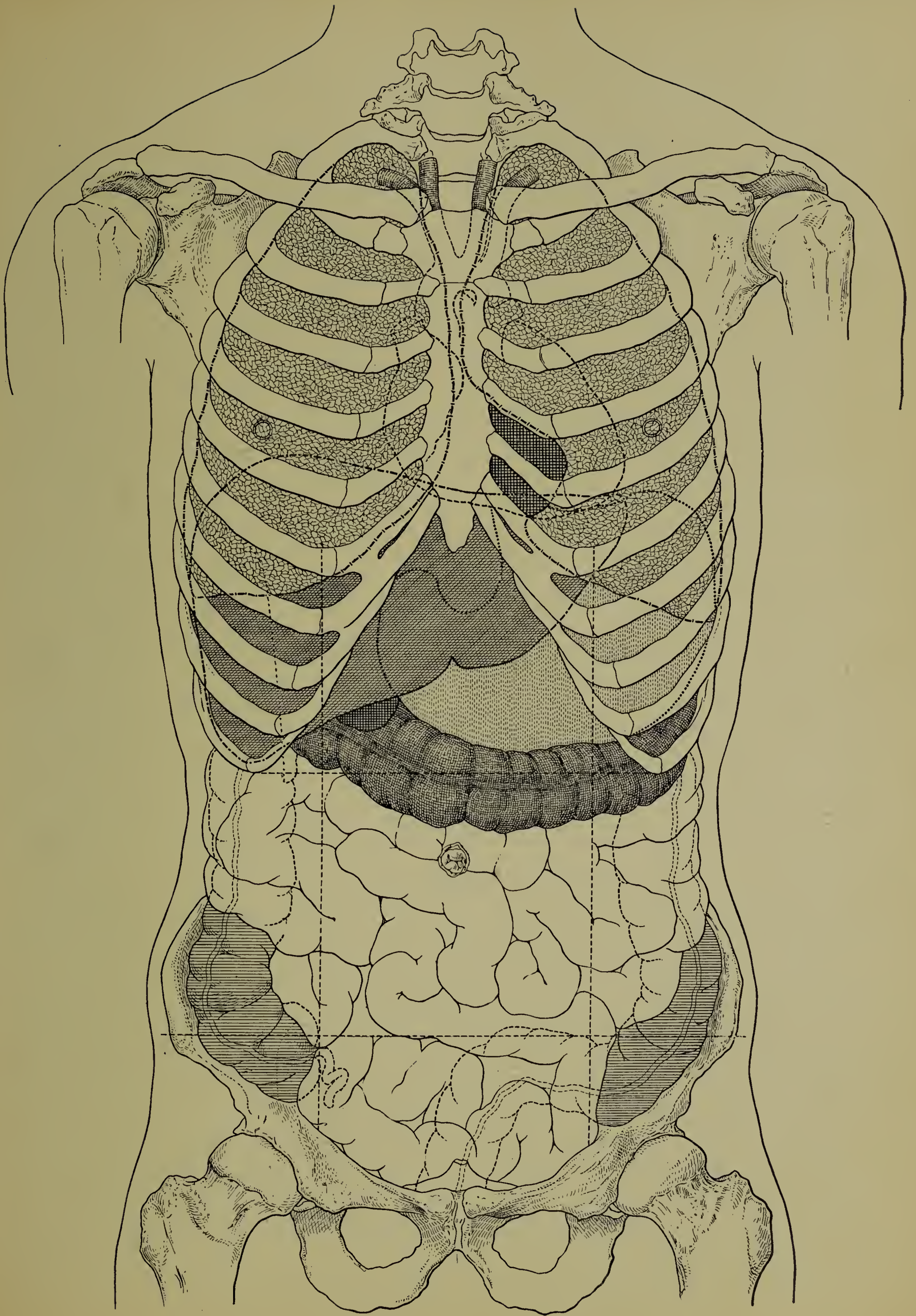


DIAGRAM OF ABDOMINAL VISCERA AND LUNGS,—ANTERIOR VIEW.

viscera by the extraperitoneal connective tissue. The area of its surface nearly equals that of the integument of the body, and it is greater than the surface area of any other serous membrane in the body. In the male it forms a closed sac, and in the female its only orifice of communication with the exterior of the body is at the fimbriated extremity of the Fallopian tube, where the lumen of that tube communicates with the peritoneal cavity. Its arrangement is more complicated than that of other serous membranes, each of which is in relation with one viscus, whereas the peritoneum is in relation with a number of viscera, over and partially around which it passes.

The **peritoneal sac** is a large lymph-space which acts as a bursa for the abdominal viscera and abdominal wall, and permits movement of the viscera and abdominal walls without friction. Within this sac is a small quantity of serous fluid, which is distributed over the internal surface of the peritoneum and should be sufficient to lubricate that surface of the membrane. This fluid is constantly carried away by lymphatic vessels which are in free communication with the inner surface of the peritoneum between the endothelial cells lining that surface. These lymphatics eventually empty into the receptaculum chyli; consequently obstruction of the thoracic duct is a cause of **ascites**, or excess of peritoneal fluid. Ascites is caused also by any of the common causes of dropsy, by obstruction of the portal vein, or by chronic peritonitis.

The absorptive power of peritoneum.—The great rapidity with which material can be absorbed from the peritoneal cavity is explained partly by the bountiful supply of lymphatic vessels which drain the inner surface of the peritoneum, and partly by the extensive area of the membrane thus so freely drained.

Owing to the great absorptive power of the peritoneum, septic intoxication is more likely to follow and occurs much earlier after the introduction of infectious matter into the peritoneal sac than after similar introduction into the pleural sac or other serous cavities. This is explained partly by the greater area of the peritoneum and partly by the tendency of the more movable contents of the abdomen to disseminate the infectious matter. The portion of the peritoneum in relation with the small intestine is more sensitive to infection than are other portions of the peritoneum, on account of the tendency of the small bowel to spread the infection by movement.

Localized **peritonitis** may exist only in those regions which are not occupied by coils of the small intestine, as between the diaphragm and the level of the transverse colon, on the outer side of the cecum, and in the pelvis. Consequently peritonitis in perihepatic inflammation, appendicitis, or salpingitis is often circumscribed and not necessarily fatal.

Pus in relation with the external surface of the peritoneum, as in perinephritic abscess, is unlikely to cause diffuse peritonitis unless it ruptures into the peritoneal cavity, because it can not spread rapidly over a large area of the peritoneum. Infectious matter on the external surface of the peritoneum is less likely to cause rapid septic intoxication than the same matter on the internal surface of the peritoneum, because in the latter case the infectious matter will be widely distributed over the peritoneum if it come into contact with the jejunum or ileum; also a more extensive surface offers greater opportunity for absorption, and the area of peritoneum in relation with the small intestine and mesentery is extensive.

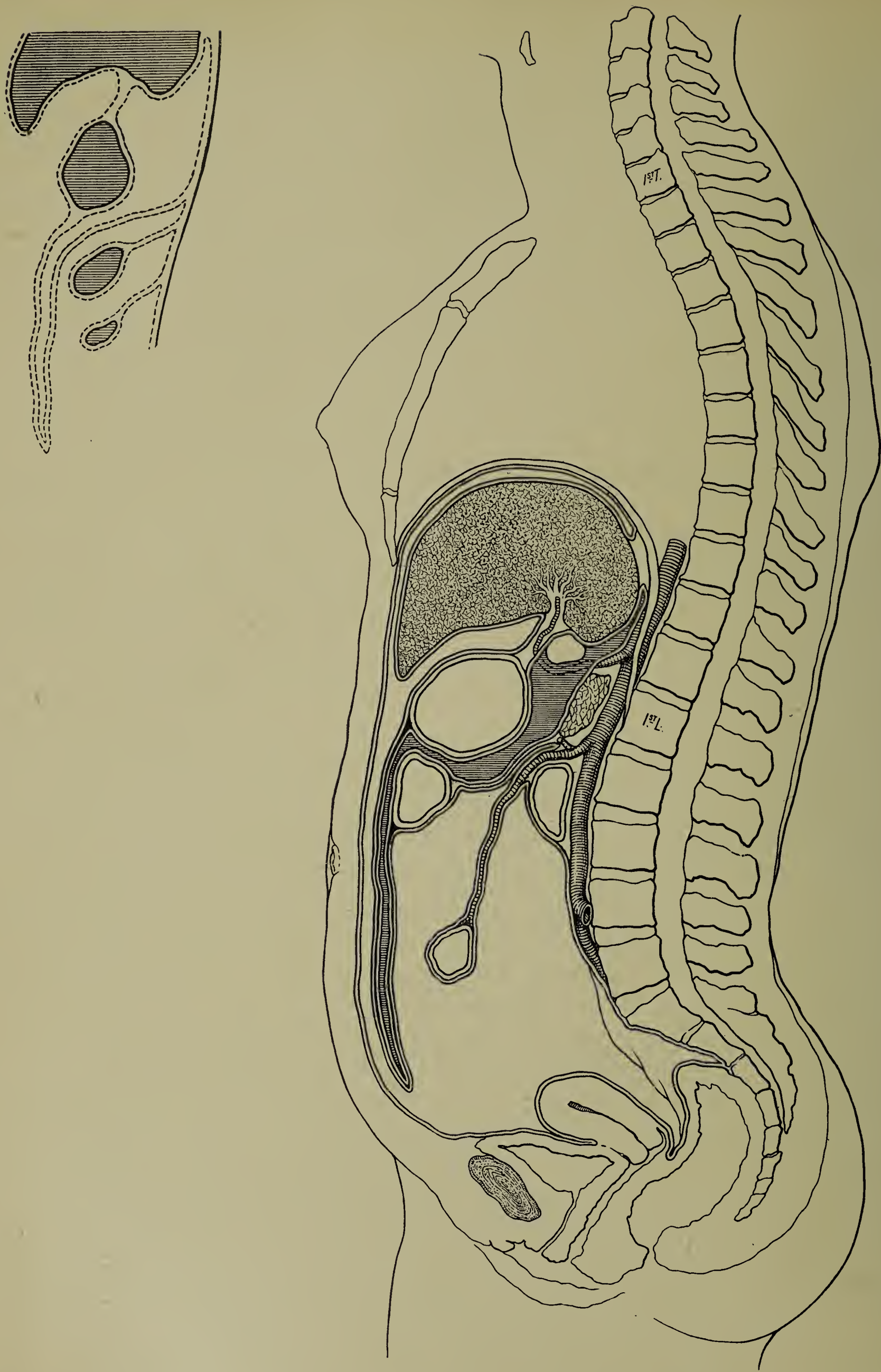
Peritonitis may lead to the development of various forms of connective-tissue bands or adhesions, beneath which a loop of intestine may become strangulated.

The peritoneum admits of great stretching, provided the force is applied gradually. This is proved in the development of abdominal herniæ, especially in the umbilical variety, in which a circumscribed portion of the peritoneum is stretched to form the sac of the hernia. The sudden application of force to the peritoneum ruptures it. The parietal portion of the peritoneum may be ruptured with or without injury of the viscera.

The peritoneum is divided into a **parietal portion**, which is in relation with the walls of the abdominal cavity, and a **visceral portion**, which is in relation with the viscera.

Attachments of the peritoneum.—The loose attachment of the peritoneum, except at the umbilicus and the diaphragm, explains the readiness with which pus from a hepatic abscess which has ruptured extraperitoneally finds its way to the linea alba through the subperitoneal connective tissue, which is between the transversalis fascia and peritoneum; or how a perinephritic abscess can dissect up the peritoneum, to reach finally the opposite side of the vertebral column. The ease with which the peritoneum can be stripped up from the iliac fossa in ligation of the external iliac artery is another demonstration of the same fact. Its attachment to the abdominal walls is not very firm, except in two locations—the lower surface of the diaphragm and the region immediately surrounding the umbilicus. The sac of an umbilical hernia is not, therefore, formed so much by a protrusion of the peritoneum as by a gradual thinning of a circumscribed portion of the membrane immediately in relation with the umbilicus. The sac of an umbilical hernia may almost entirely disappear from this cause. It is more difficult to free the neck of the sac in performing an operation for the radical cure of this form of hernia than in other forms, on account of the adherence between the peritoneum, the transversalis fascia, and the transversalis aponeurosis at the umbilicus.

The **peritoneal cavity** is the cavity inclosed by the peritoneum, and is divided into two parts, the greater peritoneal cavity and the lesser peritoneal cavity, which



PERITONEUM TRACED VERTICALLY IN THE FETUS AND THE ADULT.

communicate with each other through a narrow passage—the foramen of Winslow. It contains a small quantity of serum, whose function it is to lubricate these layers, thereby preventing friction during peristalsis. None of the abdominal viscera is in the peritoneal cavity, as the peritoneum is reflected over or partially around them.

Reflections of the Peritoneum.—Besides forming a complete or partial covering for nearly all the abdominal viscera, in certain situations the peritoneum is reflected from one organ to another and from the organs to the walls of the abdomen, thus forming reflections or folds which receive special names according to their location, as the mesentery, omentum, meso-colon, and certain ligaments.

The peritoneum is a continuous membrane, and as such may be traced both vertically and transversely.

Vertical course of the peritoneum.—In tracing the peritoneum vertically a convenient point from which to start is the transverse fissure of the liver. With the liver drawn upward and outward, by grasping its lower edge with one hand while with the other the stomach is carried downward and to the left, a double fold (the gastro-hepatic or lesser omentum) is seen to descend to the lesser curvature of the stomach, and is stretched between these two organs. Reaching the stomach, the two layers separate to inclose that organ, one layer passing in front of it and the other behind it. At the greater curvature they again meet, and pass downward, like an apron, over the small intestine, to the lower part of the abdomen, forming the two anterior layers of the great omentum; they then turn on themselves and ascend to the transverse colon, having by this last reflection formed the two posterior layers of the great omentum. They again separate and inclose this portion of the colon, one layer passing above and one beneath it. Along the posterior surface of the transverse colon these two layers again meet and form the transverse meso-colon, which passes to the posterior wall of the abdominal cavity; opposite the lower border of the pancreas they divide into an ascending and a descending layer. The ascending layer passes in front of the pancreas, the second portion of the duodenum, and the crura of the diaphragm, and then to the under surface of the diaphragm, from which it is reflected to the posterior surface of the liver, forming the inferior layer of its coronary and lateral ligaments; and then to the under surface of the liver, as far as the transverse fissure, the point whence we started. Here it is continuous with the posterior layer of the lesser or gastro-hepatic omentum. The descending layer of the transverse meso-colon passes over the third portion of the duodenum—the posterior abdominal wall—and the superior mesenteric vessels to the jejunum and ileum, both of which it surrounds, and back again to the posterior part of the abdominal cavity, forming the mesentery. Thence it descends, passing in front of the aorta and inferior vena

cava into the pelvis, and, surrounding the sigmoid flexure of the colon, connects it with the posterior part of the pelvic cavity by the meso-sigmoid. It covers the anterior surface of the first portion of the rectum, from which, in the male, it is reflected upon the posterior wall and sides of the bladder, forming the posterior and lateral false ligaments of the bladder and the recto-vesical pouch.

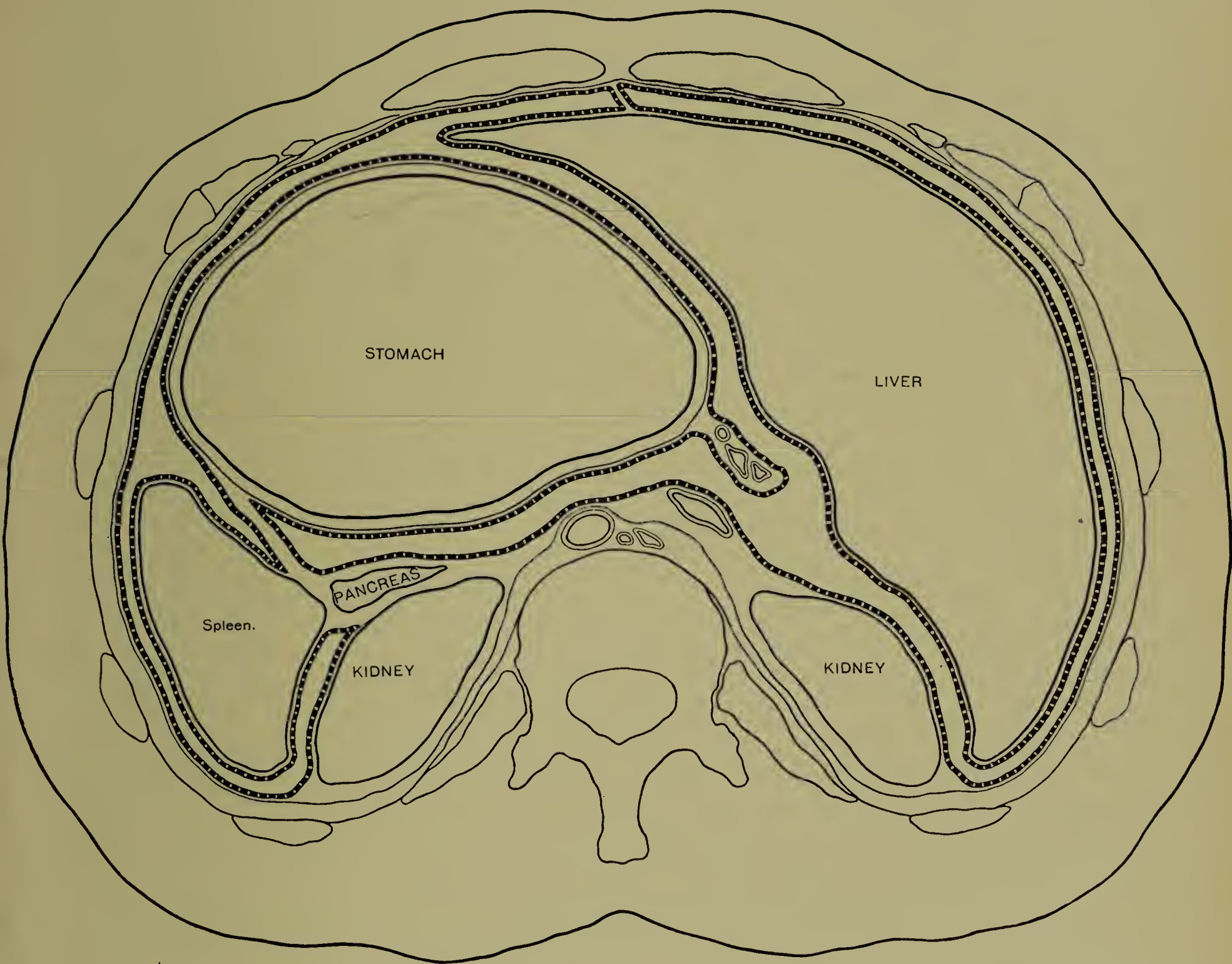
The sides of the **recto-vesical pouch** are formed by the posterior false ligaments of the bladder. The depth of the pouch varies with the distention of the bladder, which, when full, carries the floor of the pouch up with it, thus lessening its depth. When the bladder is empty, the floor of the pouch is two inches (five centimeters) from the anus; when the bladder is distended, the floor of the pouch is carried about two inches higher, or to about four inches (ten centimeters) from the anus.

In the female the peritoneum is reflected from the rectum to the upper part of the vagina, and then covers the sides, back, summit, and slightly more than the upper half of the front of the uterus, forming the **recto-vaginal pouch**, or **Douglas' pouch**. The folds of peritoneum forming the sides of Douglas' pouch are the recto-uterine or posterior false ligaments of the uterus; they contain the utero-sacral ligaments, which are composed of muscular and connective tissue. From the sides of the uterus, as well as from the upper part of the posterior wall of the vagina, which it covers, the peritoneum is reflected to the sides of the pelvis, forming the lateral, or broad, ligaments of the uterus. From the sides and front of the uterus it is reflected to the sides and posterior wall of the bladder, forming the **utero-vesical pouch**; and from the sides and summit of the bladder it passes as it does in the male. The folds of peritoneum forming the sides of the utero-vesical pouch are the anterior false ligaments of the uterus, the uterovesical false ligaments, or the posterior false ligaments of the bladder.

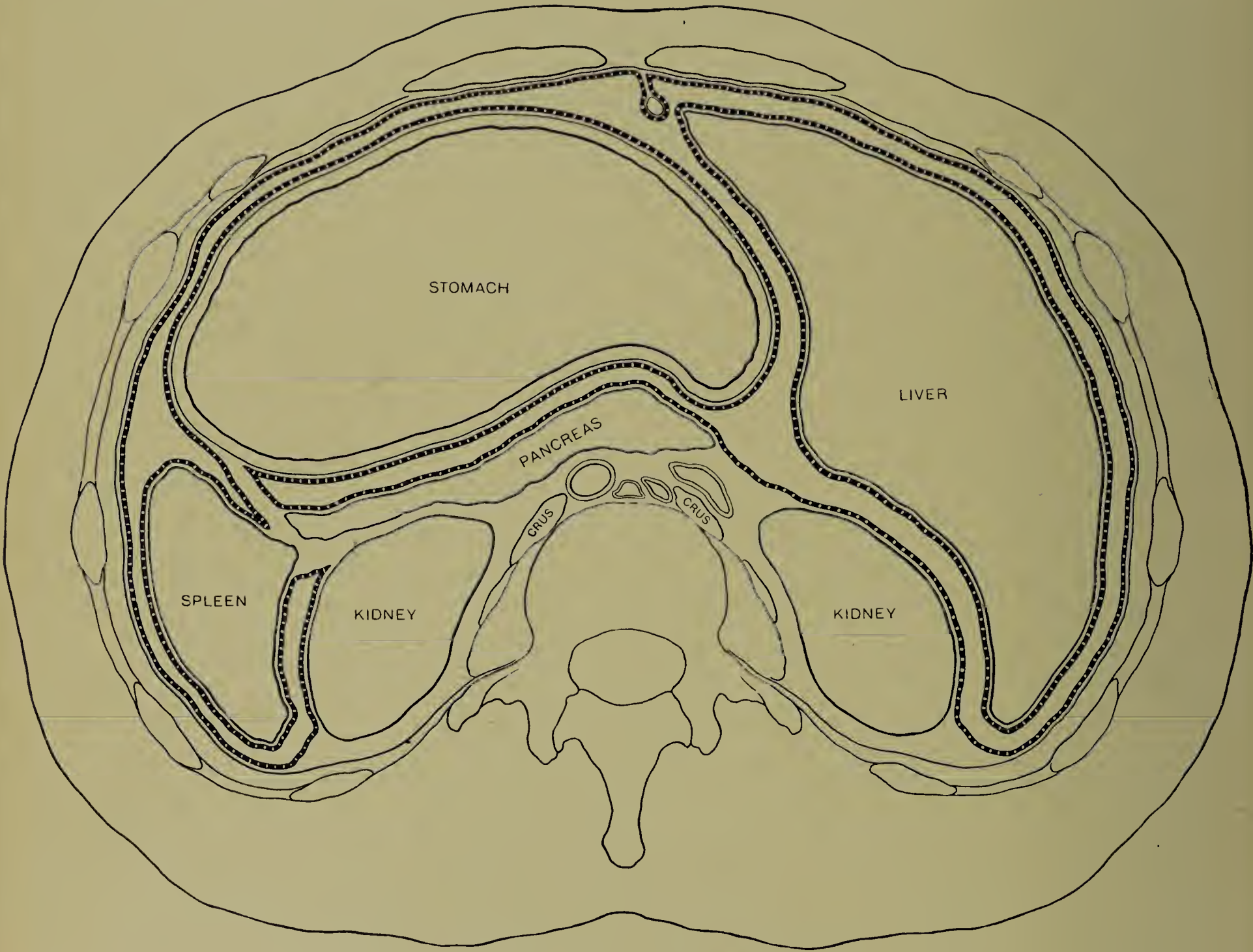
From the summit and sides of the bladder the peritoneum passes to the anterior and lateral abdominal walls. It is continued upward anteriorly, and lines the anterior wall of the abdomen and the under surface of the diaphragm, from the latter of which it is reflected upon the posterior surface of the liver, forming the superior layer of the coronary and lateral ligaments of the liver. Thence it passes over the superior surface of the liver and around the anterior border to the under surface of that organ, where, at the transverse fissure, the point of starting, it is continuous with the anterior layer of the lesser omentum.

In tracing the peritoneum in this manner it will be seen that the anterior layer forms the walls of the greater peritoneal cavity, while the posterior layer forms the walls of the lesser peritoneal cavity.

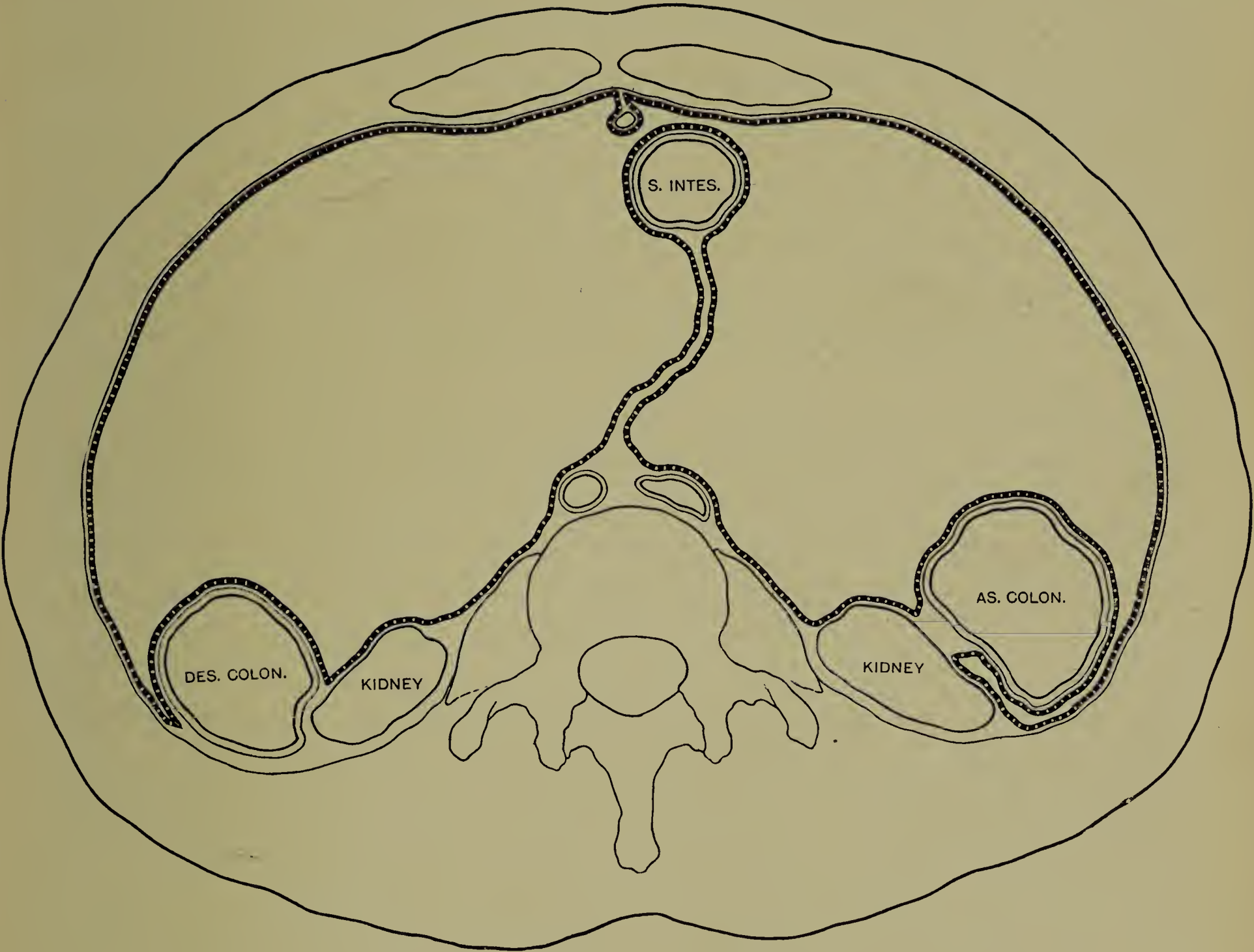
Transverse course of the peritoneum.—The peritoneum should be traced transversely at two levels—above and below the level of the transverse colon. In



PERITONEUM TRACED AT THE LEVEL OF THE FORAMEN OF WINSLOW.



PERITONEUM TRACED ABOVE THE LEVEL OF THE TRANSVERSE COLON.



PERITONEUM TRACED BELOW THE LEVEL OF THE TRANSVERSE COLON.

each instance we start at the median line of the anterior abdominal wall, and begin to trace the peritoneum toward the right side.

Below the level of the transverse colon, starting at the median line and tracing the peritoneum to the right, it will be seen to cover the internal surface of the abdominal wall nearly as far as the outer border of the quadratus lumborum muscle, whence it is reflected upon the inner, anterior, and outer surfaces of the ascending colon, forming the ascending meso-colon. Having returned from the ascending colon to the posterior abdominal wall, it passes in front of the right kidney, superior mesenteric vessels, inferior vena cava, and duodenum. It is then reflected around the jejunum and ileum, and returns to the posterior abdominal wall, forming the mesentery. From the root of the mesentery it passes to the left, in front of the aorta, inferior mesenteric vessels, and left kidney, and is reflected over the sides and front of the descending colon, forming the descending meso-colon. Below it envelops the sigmoid flexure and returns to the posterior abdominal wall, forming the meso-sigmoid. From the descending colon it passes along the lateral and anterior abdominal wall to reach the middle line, the point from which we started.

Above the transverse colon, and at the level of the foramen of Winslow, or at the level of the first lumbar vertebra, beginning at the median line and tracing it to the right, the peritoneum is reflected around the round ligament of the liver, forming part of the falciform or broad ligament of that organ. Thence it follows the abdominal wall, covering the right kidney, pancreas, inferior vena cava, aorta, and part of the left kidney. It passes from the anterior surface of the left kidney to the anterior surface of the spleen, just in front of the hilum, forming the right layer of the lieno-renal ligament, and thence to the cardiac end of the stomach, forming the posterior layer of the gastro-splenic omentum. It passes over the posterior surface of the stomach to its pyloric extremity, where it turns around the first portion of the duodenum. In turning just above the level of the duodenum it forms the right or free border of the lesser or gastro-hepatic omentum, and incloses the hepatic, cystic, and common bile ducts, the hepatic artery, and the portal vein. It next follows the anterior surface of the stomach to its cardiac end, whence it passes to the anterior surface of the spleen, just in front of the hilum, forming the anterior layer of the gastro-splenic omentum. From the anterior margin of the hilum of the spleen it passes around that organ to the posterior margin of the hilum, and again to the posterior abdominal wall, to the front of the left kidney, forming the left layer of the lieno-renal ligament. From this position it passes over the outer portion of the kidney and follows the abdominal wall to the median line, whence we started.

The portions of the peritoneum inclosing each peritoneal cavity may also be

traced separately in a vertical direction. To trace the portion of the **peritoneum in relation with the greater peritoneal cavity** we begin, as before, at the transverse fissure of the liver. From the transverse fissure of the liver the peritoneum passes to the lesser curvature of the stomach, forming the anterior layer of the gastro-hepatic omentum. It covers the anterior surface of the stomach, and descends from the greater curvature of that organ, forming part of the anterior layer of the great omentum. At the lower border of that omentum it turns upward to the transverse colon, forming part of the posterior layer of the great omentum. It passes under the transverse colon and thence to the posterior abdominal wall, forming the inferior layer of the transverse meso-colon. It next descends, on the posterior abdominal wall, in front of the transverse portion of the duodenum, the aorta, the inferior vena cava, and the superior mesenteric vessels, and is reflected around the ileum and jejunum and back to the abdominal wall, forming the two layers of the mesentery. It then runs over the aorta, inferior vena cava, and inferior mesenteric vessels to the pelvis, where it envelops the termination of the sigmoid flexure, and covers the anterior surface of the first portion of the rectum, from which, in the male, it is reflected upon the posterior surface of the bladder, forming the floor of the recto-vesical pouch. In the female it is reflected from the rectum upon the upper portion of the posterior wall of the vagina and thence to the uterus, forming the floor of the recto-vaginal or Douglas' pouch. It passes around the uterus to its anterior surface, forming the broad ligaments at the sides of that organ. From the anterior aspect of the uterus it passes to the bladder, forming the utero-vesical pouch. In both sexes it covers the posterior surface and sides of the bladder, and follows the anterior abdominal wall to the diaphragm, from the posterior part of which it descends to the liver, forming the anterior or the superior layer of the coronary and lateral ligaments of the liver. Thence it passes around the anterior aspect of the liver to the transverse fissure, whence we started.

The **peritoneum bounding the lesser peritoneal cavity** is traced from the transverse fissure of the liver to the lesser curvature of the stomach, forming the posterior layer of the lesser or gastro-hepatic omentum. It follows the posterior surface of the stomach to its greater curvature, from which it descends, forming the inner part of the anterior layer of the great omentum. It turns within the lower border of the great omentum, and ascends to the transverse colon, forming the internal part of the posterior layer of the great omentum. It next runs in front of the transverse colon to the posterior abdominal wall, forming the upper layer of the transverse meso-colon. Thence it passes upward on the posterior abdominal wall, over the pancreas and great vessels to the diaphragm, from which it descends to the liver, forming the posterior or inferior layer of the coronary and

lateral ligaments of that organ. It next passes along the under surface of the liver to the transverse fissure, the point from which we started.

In the fetus the peritoneum of the greater peritoneal cavity, in relation with the transverse colon, takes a slightly different course. Beginning at the greater curvature of the stomach, it is traced downward, forming the outer part of the anterior layer of the great omentum. It turns at the lower border of that omentum and ascends, forming the outer part of the posterior layer of the great omentum. It next passes in front and free of the transverse colon to the posterior abdominal wall, at about the level of the pancreas, whence it turns downward to envelop the transverse colon and returns to the posterior abdominal wall, forming the transverse meso-colon. Below this point it takes the same course as in the adult. From this description it will be seen that the two layers of peritoneum forming the posterior layer of the great omentum lie in front of the upper layer of the transverse meso-colon. In the adult these two layers become adherent to the transverse meso-colon, so that the upper layer of this meso-colon is really composed of three layers of peritoneum.

The **Lesser Peritoneal Cavity**, or the cavity of the great omentum, is surrounded by the ascending and the descending layers of the great omentum, the lesser omentum, the transverse meso-colon, and that portion of the peritoneum which covers the posterior abdominal wall above the transverse meso-colon. It is bounded in front by the lobus Spigelii, the lesser omentum, the stomach, the gastro-splenic omentum, and the descending layers of the great omentum; behind, by the ascending layers of the great omentum, the transverse colon, the transverse meso-colon, and the peritoneum covering the pancreas, great vessels, left kidney, and suprarenal body; above, by the lobus Spigelii of the liver and by the diaphragm; and below, by the turn of the great omentum. On the left side it is limited by the spleen and lieno-renal ligament and the junction of the anterior and posterior layers of the great omentum.

The **Greater Peritoneal Cavity** is the space seen after dividing the anterior parietal peritoneum. It is separated from the lesser peritoneal cavity by the liver, lesser omentum, stomach, great omentum, gastro-splenic omentum, lieno-renal ligament, and transverse meso-colon. It communicates with the lesser cavity through the foramen of Winslow.

The **Foramen of Winslow** may be located by drawing the liver upward and the stomach downward, and then carrying the finger behind the right or free border of the gastro-hepatic omentum, which border is just below the neck of the gall-bladder. This foramen is bounded, in front, by the right or free border of the lesser omentum, between the two layers of which are the hepatic artery, the portal vein, and the hepatic duct; behind, by the inferior vena cava, which is covered by

the peritoneum; above, by the caudate lobe of the liver; and below, by the first portion of the duodenum and the hepatic artery, curving forward from the celiac axis. In the new-born child, before the layers of the great omentum have become adherent, the lesser peritoneal cavity can be inflated by means of a blow-pipe introduced through the foramen of Winslow. When the foramen of Winslow becomes closed by adhesive inflammation, the usual free communication between the two peritoneal cavities does not exist. A collection of fluid in the lesser cavity under these circumstances would be strictly localized, and would constitute the condition known as **hydrops saccatus**.

Hernia through the foramen of Winslow, one of the varieties of internal hernia, has been observed.

The **Viscera almost Entirely Surrounded by the Peritoneum** are the liver, stomach, spleen, first portion of the duodenum, jejunum, ileum, cecum, vermiform appendix, transverse colon, sigmoid flexure, and ovaries. Wounds and perforations of these organs almost invariably involve the peritoneum. Exceptions to this rule occur in the case of perforations of the vermiform appendix near its base and along the attachment of the meso-appendix, and wounds and abscesses involving the nonperitoneal portion of the posterior surface of the liver. Inflammatory diseases of the organs almost entirely covered by peritoneum may cause peritonitis, appendicitis being a common cause of peritonitis.

The **Viscera Partially Surrounded by the Peritoneum** are the descending, the transverse, and the terminal ascending portion of the duodenum, the ascending and the descending colon, the first portion of the rectum, the vagina, the uterus, and the bladder. Wounds or perforations of these organs do not necessarily involve the peritoneum.

The **Viscera which have no Peritoneal Covering** are the second or lowest portion of the rectum, the pancreas, the kidneys, and the suprarenal bodies. It should also be noticed that the neck, base, and anterior wall of the bladder and the anterior wall and the lower part of the posterior wall of the vagina are not covered by the peritoneum. Those organs which are behind the peritoneum are the kidneys, the suprarenal bodies, and the pancreas; these are said to be retro-peritoneal structures. The retro-peritoneal organs can be wounded without inflicting injury on the peritoneum, and inflammatory diseases of these organs are unlikely to cause peritonitis.

The several **Processes or Folds of the Peritoneum** extending between the various viscera and between the viscera and the abdominal walls are known as ligaments, omenta, mesenteries, or meso-colons. Their function is twofold—namely, to hold the viscera in position and, as in the case of the omenta, the mesentery, the meso-colons, and the ligaments in the pelvis, to transmit vessels and nerves between their layers.

The **Peritoneal Ligaments** in the abdominal cavity proper are the coronary, suspensory, and lateral ligaments of the liver, the suspensory ligament of the spleen (phreno-splenic), and the lieno-renal, the gastro-phrenic, and the phreno-colic ligaments.

The **suspensory or falciform ligament of the liver** extends from the upper convex surface of the liver to the diaphragm and anterior abdominal wall. It is attached by its convex border to the diaphragm and the posterior surface of the sheath of the right rectus muscle as low down as the umbilicus, and by its lower concave border to the upper surface of the liver, between the anterior and posterior margins. Posteriorly it is continuous with the coronary and lateral ligaments of the liver. Its free border, which extends from the umbilicus to the anterior border of the liver, contains the round ligament between its two layers.

The **lateral ligaments of the liver** are triangular in shape, the left being much larger than the right. The right lateral ligament is a small fold extending from the right extremity of the posterior nonperitoneal surface of the liver to the diaphragm. The left lateral ligament passes from the posterior portion of the superior surface of the left lobe of the liver to the inferior surface of the diaphragm.

The **coronary ligament of the liver** is situated at the junction of the lateral and suspensory ligaments, and consists of two layers, which, however, are separated from each other by a space equal to the breadth of the nonperitoneal area of the posterior surface of the liver.

The **phreno-splenic ligament, or suspensory ligament of the spleen**, extends between the upper border of the spleen and the diaphragm.

The **lieno-renal ligament** passes from the hilum of the spleen to the front of the left kidney, and contains between its two layers the splenic vessels, nerves, and lymphatics and the tail of the pancreas.

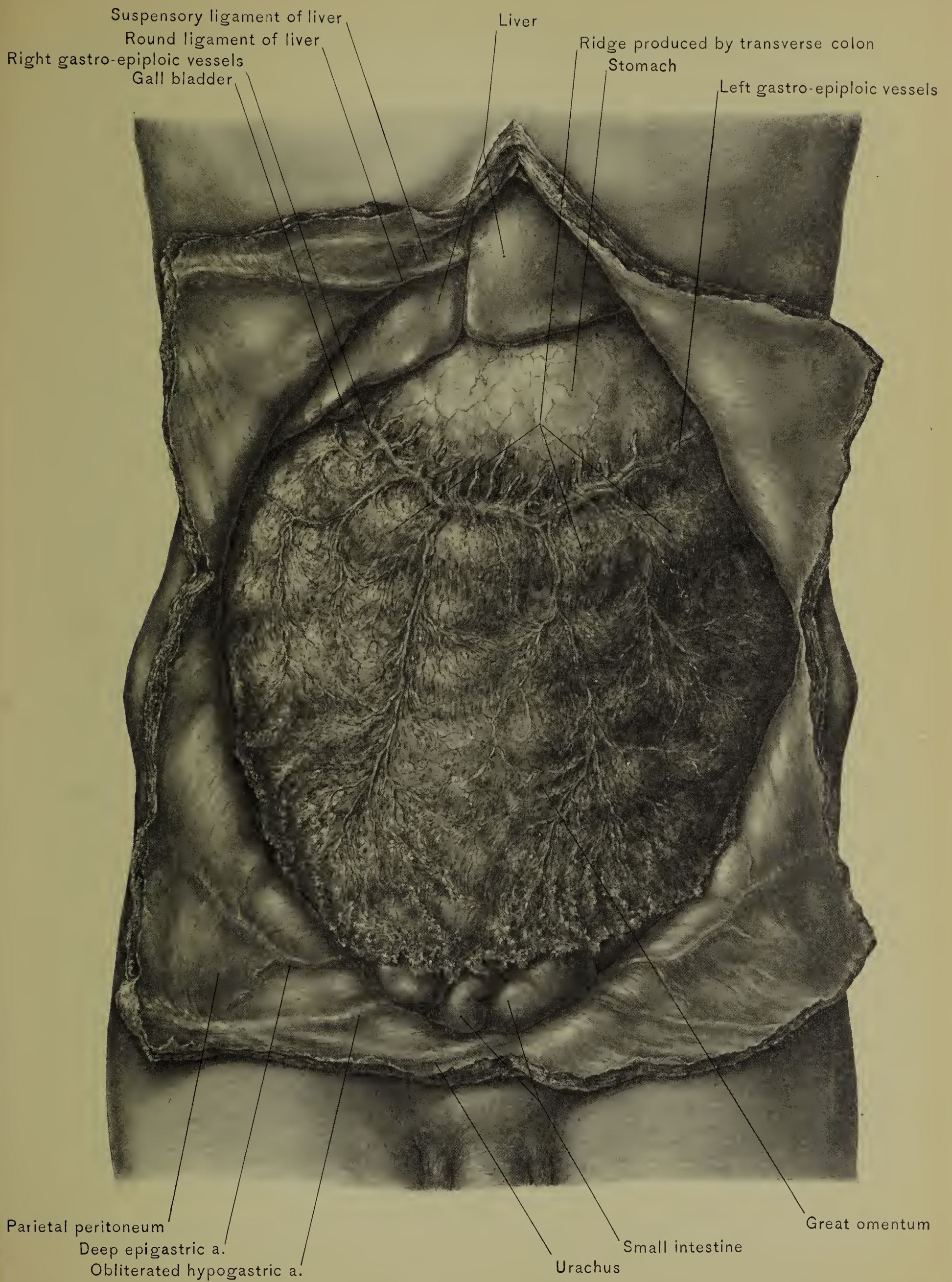
The **gastro-phrenic ligament** is a fold of peritoneum running between the diaphragm and the cardiac end of the stomach to the left of the esophagus.

The **phreno-colic ligament** is a fold of peritoneum which extends from the splenic flexure of the colon to the diaphragm, opposite the tenth and eleventh ribs.

The **peritoneal ligaments of the bladder** consist of two lateral, two posterior, and a superior ligament. The lateral and posterior ligaments are in the pelvic cavity. The superior ligament is a prominent fold which extends from the summit of the bladder to the umbilicus, and covers the urachus and the obliterated hypogastric arteries.

The **Omenta** are folds of peritoneum which connect the stomach with adjacent viscera, and are three in number—viz., the gastro-colic or great omentum, the gastro-hepatic or lesser omentum, and the gastro-splenic omentum.

The **great omentum**, or **gastro-colic omentum**, the largest of all the peritoneal folds, is suspended from the greater curvature of the stomach and the free border of the transverse colon. It usually covers the small intestine as far as the pelvis, extending almost to the summit of the bladder. It consists of a double descending and a double ascending layer; between these layers is a large part of the lesser peritoneal cavity, which is, therefore, sometimes called the cavity of the great omentum. Between the two layers of the descending or anterior layer of the great omentum, along the greater curvature of the stomach, is the arterial loop formed by the anastomosis between the right and left gastro-epiploic arteries. In the adult the portion of the lesser peritoneal cavity within the great omentum is usually partly obliterated by the adherence of its anterior to its posterior layer. In corpulent persons the great omentum contains a large quantity of fat; while in thin subjects it is thin and translucent. In the infant at birth it is quite short, scarcely extending to the umbilicus. It protects the small intestine against cold. The length of the great omentum varies: in some bodies it is quite short and crumpled up, while in others it extends into the pelvis, in which case it is sometimes difficult to keep it out of the way of the fingers in enucleating even a small pelvic tumor. This difficulty is overcome by placing the patient in the Trendelenburg posture,—*i. e.*, with the pelvis elevated,—so that the intestines and omentum rise out of the pelvis, and then walling off the upper portion of the peritoneal cavity and the intestines with gauze. When the omentum is in the pelvis, it is also frequently found adherent to inflammatory masses located there. As a result of peritonitis the great omentum may be found attached to the anterior wall of the abdominal cavity, the bladder, the uterus, the mesentery, or any adjacent viscus. The matting together of the viscera, great omentum, and other portions of the peritoneum in peritonitis serves a useful purpose by checking extravasation of blood and visceral contents. In perforation of the viscera, as in appendicitis and in ulceration of the gall-bladder, adhesions between the omentum and adjacent structures may prevent dissemination of visceral contents throughout the peritoneal cavity. In performing an abdominal section for a pathologic condition in the pelvis it may be found advisable to break through an adherent omentum instead of dissecting it free. A rent or slit in the great omentum, whether produced by operation or accident, should be sutured before closing the abdomen, for fear that a loop of intestine may subsequently find its way through the aperture and acute mechanical intestinal obstruction occur. If it is necessary to allow a drainage-tube to remain, the omental opening should be closed as far as the site of the tube. Omental herniæ of either the inguinal or the femoral variety are more common in persons in whom the great omentum is long, and the vomiting and epigastric pain that sometimes occur in this form of hernia are explained



ABDOMINAL VISCERA AND GREAT OMENTUM.

by the traction of the omentum. When both omentum and intestine are occupants of a hernial sac, the omentum usually lies in front of the bowel, and frequently becomes adherent to both the sac and the intestine. At times the omentum in a hernia becomes hypertrophied, or elongated, or cystic, resembling in appearance a testicle, or yet again the small intestine; at other times it is atrophied, and in congenital inguinal herniæ an elongated thin band of the omentum is frequently found attached to the testicle. After a certain percentage of abdominal sections the great omentum will form adhesions. These produce much discomfort, and may necessitate reopening the cavity and freeing the adhesions. In closing an abdominal incision in corpulent individuals it is necessary to exercise great care to prevent the great omentum from being included between the edges of the wound when tying the sutures. Lying, as it does, just internal to the abdominal walls, the great omentum sometimes prevents the flow of fluid through the trocar when the operation of paracentesis abdominalis is performed. The omentum or intestine which prevents the flow of the serum may be pushed away by a probe introduced through the trocar. Because of its position the great omentum almost always forms part of the contents of the sac of an umbilical hernia. The great omentum lies so close to the anterior wall of the abdomen that it is frequently wounded, and may act as a plug in these wounds, preventing protrusion of the intestine or other viscera. When this omentum is adherent to the abdominal wall, intestine, pelvic viscera, or mesentery, a loop of intestine may be caught over a band thus formed, causing acute intestinal obstruction.

A tumor deprived of its original source of blood supply, as an ovarian cyst or a pedunculated fibroid twisted on its pedicle, may be nourished through adhesions between it and the great omentum. Thus, gangrene of the tumor may be prevented. Because of its position, this omentum is likely to be injured in penetrating wounds of the anterior abdominal walls.

The **lesser omentum** extends between the transverse fissure of the liver and the lesser curvature of the stomach. The right border is free and forms the anterior boundary of the foramen of Winslow, while the left border is attached to the diaphragm and greater curvature of the stomach. That portion of the lesser omentum which passes beyond the esophagus forms the gastro-phrenic ligament or omentum.

The lesser omentum consists of two layers of peritoneum; these have been demonstrated in tracing the peritoneum vertically. Between these two layers, at the right or free border, pass the portal vein, hepatic artery, hepatic, cystic, and common bile ducts, and nerves and lymphatics. The common bile duct, hepatic artery, and portal vein bear the following relation to one another: the duct lies to the right; the artery, to the left; and the vein, between and behind the two, but nearer to the duct than to the artery. Between the layers, along their attach-

ment to the lesser curvature of the stomach, is the arterial loop formed by the anastomosis between the gastric artery and the pyloric branch of the hepatic artery.

The **gastro-splenic omentum** extends between the fundus of the stomach and the hilum of the spleen, and is continuous below with the great omentum. It consists of two layers of peritoneum, between which pass the vasa brevia of the splenic artery, which run to the fundus of the stomach.

The **Mesentery** is the fan-shaped suspensory ligament of the jejunum and ileum, or all of the small intestine except the upper ten to twelve inches (twenty-five or thirty centimeters). It is composed of extraperitoneal connective tissue, blood-vessels, nerves, lymphatics, and an investment of peritoneum.

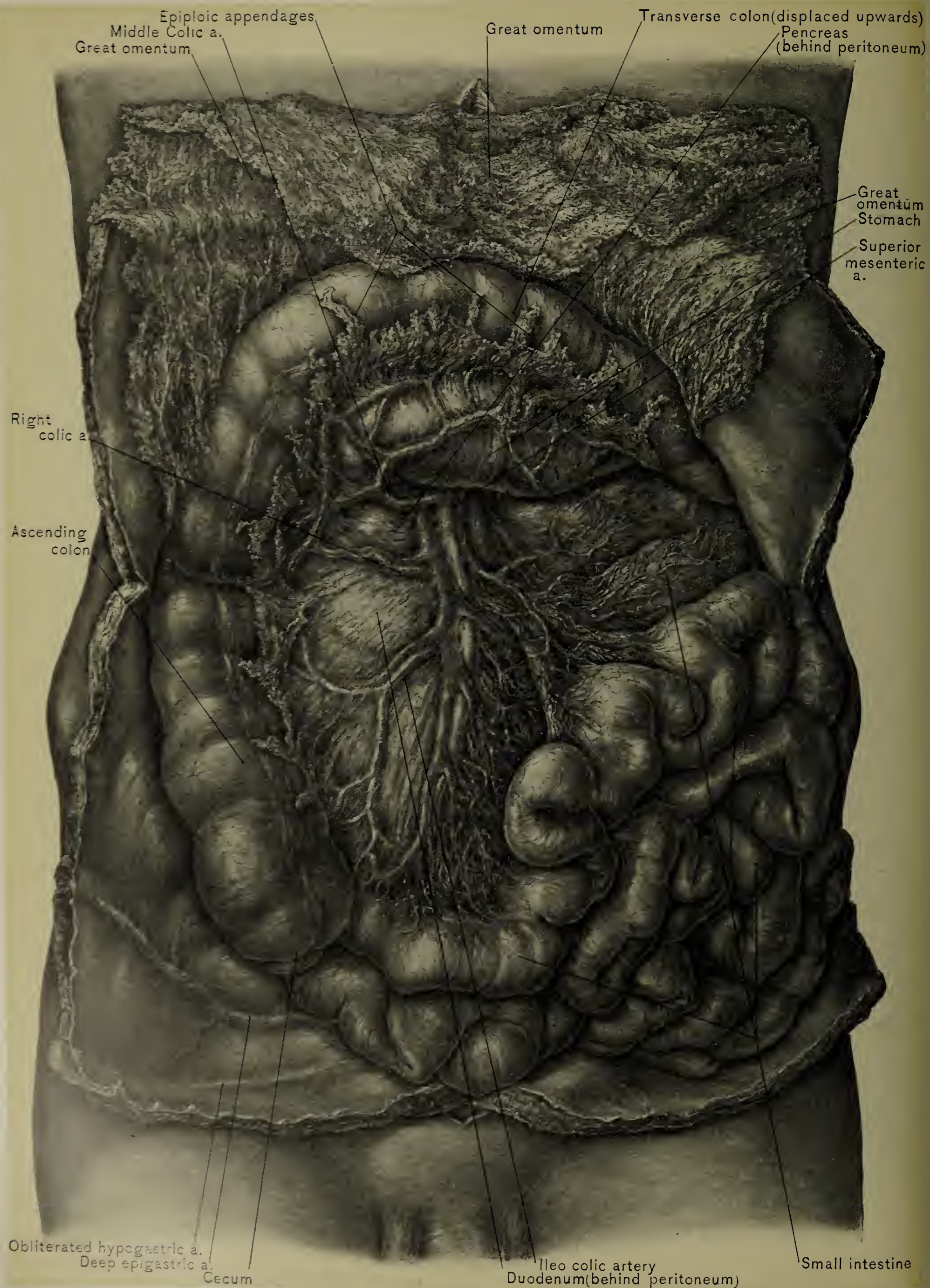
The base of the mesentery is about twenty-two feet in length (six and one-half meters) and is attached to the small intestine. The great length of the base or intestinal border of the ligament is produced by plication of the mesentery along the greater part of this border for a depth of from two and a half to three and a half inches (six to eight centimeters). The root of the mesentery is about six inches (fifteen centimeters) in length, and is attached to the posterior wall of the abdominal cavity. The line of attachment of the apex or root of the mesentery is oblique, and extends from the point of termination of the duodenum, which is about on a level with the lower border of the pancreas, and at the left side of the second lumbar vertebra, to the base of the cecum, which is in the right iliac fossa, near the right sacro-iliac articulation. The position of the lower part of this attachment probably accounts for the more frequent occurrence of inguinal and femoral herniæ on the right side. Owing to the oblique attachment of the mesentery, it follows that when hemorrhage takes place in the abdomen on the right side of the mesentery, the blood is conducted first into the right iliac fossa, and when on the left side of the mesentery, the blood gravitates into the pelvis.

The average length of the mesentery, from its vertebral to its intestinal attachment, is from eight to nine inches (twenty to twenty-two centimeters), and is greater at that part which suspends the coils of the intestine lying between six and eleven feet (two and three meters) from the duodenum, where it may reach the length of ten inches (twenty-five centimeters).

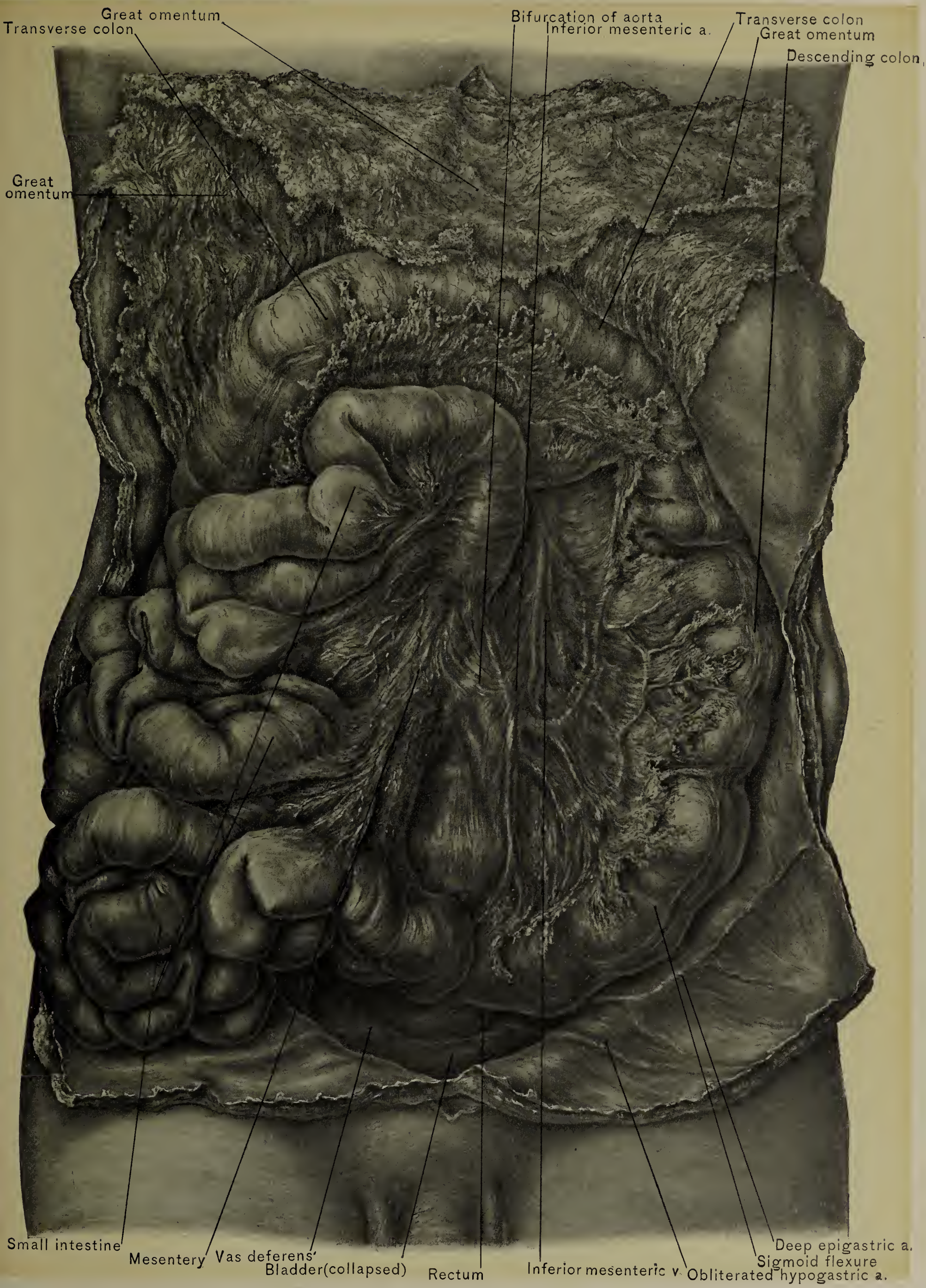
The mesentery presents two surfaces, which are both covered by peritoneum. The peritoneum on the right or upper surface is continuous with the lower layer of the transverse meso-colon and with the peritoneum which forms the inner layer of the ascending meso-colon; and the peritoneum of the lower surface, with the peritoneum which forms the inner layer of the descending meso-colon and meso-sigmoid.

In corpulent persons the mesentery, like the great omentum, contains an addi-

PLATE CCCLIII.



RIGHT SIDE OF MESENTERY CECUM, AND ASCENDING COLON.



LEFT SIDE OF MESENTERY, AND DESCENDING COLON.

tional quantity of fat. This increased weight tends to elongate the mesentery by dragging, and therefore predisposes to hernia. In the normal condition it is impossible to draw a coil of intestine through either the inguinal or the femoral canal, and it follows that before either of these herniæ can occur, there must be elongation of the mesentery. For this reason shortening of the mesentery has been suggested as a means for the radical cure of hernia.

Mesenteric openings.—Sometimes the mesentery is found to contain holes, either congenital or due to trauma, through which intestine may pass and become strangulated, constituting a mesenteric hernia. The openings due to injury are slit like, while those which are congenital are round. The latter have been shown by Treves to occupy the mesentery of the lower ileum in the oval area, circumscribed by an anastomotic arch between the ileo-colic branch of the superior mesenteric artery and the last of the vasa intestini tenuis. This portion of the mesentery is often very thin, owing to the absence of fat, vessels, and glands. In this case it presents a condition favorable for the protrusion of a loop of intestine through it.

The extraperitoneal connective tissue, which assists in forming the mesentery, transmits the blood-vessels, nerves, and lymphatics to the jejunum and ileum, and contains many lymphatic glands.

These blood-vessels are the superior mesenteric artery and vein, the vasa intestini tenuis, and their accompanying veins. The lymphatic vessels are the lacteals which carry the chyle from the small intestine to the receptaculum chyli. The nerves are derived from the superior mesenteric plexus of sympathetic nerves.

The lymphatic glands are numerous in the mesentery, and are called **mesenteric glands**. Tuberculosis of the mesenteric glands (*tabes mesenterica*) is not uncommon. Inflammation of these glands may extend to the peritoneum and agglutinate adjacent coils of intestine, producing a mass which may be mistaken for an abdominal tumor. It may also result in abscess formation. The associated local or general peritonitis may produce adhesions, bands, or a bend or twist in the gut, which may cause intestinal obstruction.

In resection of the small intestine a triangular piece of the mesentery must be excised or the mesentery must be overlapped and fixed with sutures.

The **Meso-appendix** is the fold of peritoneum which partially supports the vermiform appendix. The peritoneum of its left or upper surface is continuous with that of the lower surface of the mesentery and of the left side of the meso-cecum, and the peritoneum of its lower or right surface is continuous with that of the right surface of the meso-cecum. The meso-cecum is usually absent when the vermiform appendix is directed upward and in close relation with the cecum.

The mesentery of the appendix, or the meso-appendix, unites with the serous

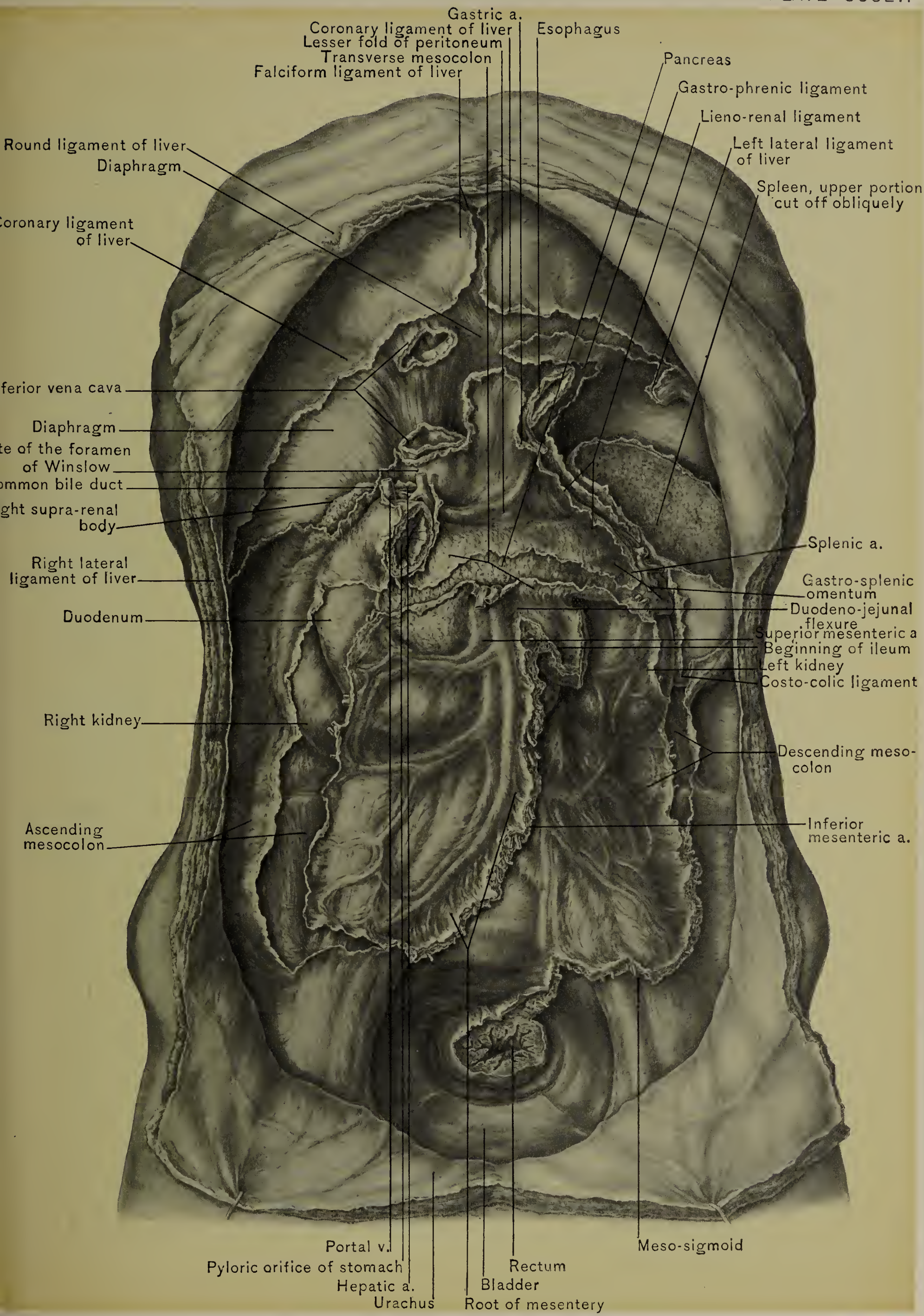
covering of the appendix, which may be complete or incomplete. In the majority of instances the entire appendix has a peritoneal covering. When but a portion is included in a peritoneal investment, the base or root is the part destitute of peritoneum, making this portion of the organ extraperitoneal. If, in appendicitis, a perforation of the vermiform appendix should take place at this location and with this disposition of the peritoneum, it can readily be understood how infection of the postperitoneal connective tissue may thus arise from this cause and result in the formation of an abscess which would be extraperitoneal. Perforation of the appendix between the layers of the meso-appendix would likewise cause infection of the postperitoneal connective tissue. The meso-appendix (mesentery of the appendix) is triangular in shape, its base corresponding to its free margin, and its sides to the appendix and the mesentery. It is attached to the appendix to the proximal one-third to two-thirds of its length, leaving the tip free, or it may be attached along the entire length of the appendix. Sometimes it may be absent entirely, or it may be so small as to be considered absent. It consists of two layers of peritoneum, between which are extraperitoneal connective tissue, the appendicular artery and vein, nerves, and lymphatics. Occasionally, and almost invariably in corpulent persons, the meso-appendix contains a considerable quantity of fat, which, during operation for removal, renders the meso-appendix likely to be torn in the delivery of the appendix through the incision in the abdominal wall. The mobility of the appendix and the ease with which it can be delivered depend upon the extent of the attachment and the width of the meso-appendix.

The meso-appendix may contain an aperture through which a loop of small intestine may project and become strangulated. The iliac vessels have been known to pass through the layers of the meso-appendix. In the female it may have a prolongation which is lost in the broad ligament; this is described by Clado as the appendiculo-ovarian ligament. Infection may be carried along this ligament from the appendix to the Fallopian tube or ovary, and thus produce a combined inflammation of both organs.

The outline of the appendix varies in accordance with the length of the meso-appendix. When the meso-appendix is short, the appendix presents an abrupt curve; if shortened in several places, the appendix may be of a cork-screw shape.

The **Meso-colons**, the folds of peritoneum holding the large intestine in place, are four in number: the ascending, the transverse, and the descending meso-colon and the meso-sigmoid.

The **ascending and the descending meso-colon** connect the corresponding portions of the colon to the posterior wall of the abdominal cavity; they are continuous with the transverse meso-colon. Both the ascending and the descending colon are covered throughout their anterior two-thirds with peritoneum, leaving the posterior



ATTACHMENTS OF MESENTERY AND MESOCOLON.

THE UNIVERSITY OF CHICAGO
LIBRARY

1911

1911

1911

1911

1911

1911

1911

1911

1911

1911

1911

1911

1911

third, where the layers of the meso-colon diverge, destitute of peritoneum; this latter portion of the wall of the bowel is connected with the posterior wall of the abdominal cavity by loose connective tissue in which there is more or less fat. In lumbar colotomy, as the portion of the bowel devoid of peritoneum is the part attacked, this connective tissue and fat must be displaced before the posterior longitudinal muscular band can be seen. In some instances both the ascending and the descending colon are completely surrounded by peritoneum—more commonly the latter. The ascending and the descending meso-colon are seldom present as distinct double folds of peritoneum, and infrequently cover more than the front and sides of the ascending and the descending portion of the colon. The ascending and descending meso-colons consist of two layers, an external and an internal. Beneath the internal layer the blood-vessels, lymphatics, and nerves pass through extraperitoneal connective tissue to the ascending and the descending colon. In opening the retro-colic space through the anterior abdominal wall, as in removal of the kidney, the external layer of the meso-colon should be divided, and not the internal, on account of the relation the blood-vessels bear to the latter.

In the **meso-colic hernia of Cooper**, a retro-peritoneal hernia, the small intestine reaches the retro-colic space of the left side by carrying before it that portion of the posterior parietal peritoneum continuous with the internal layer of the descending meso-colon.

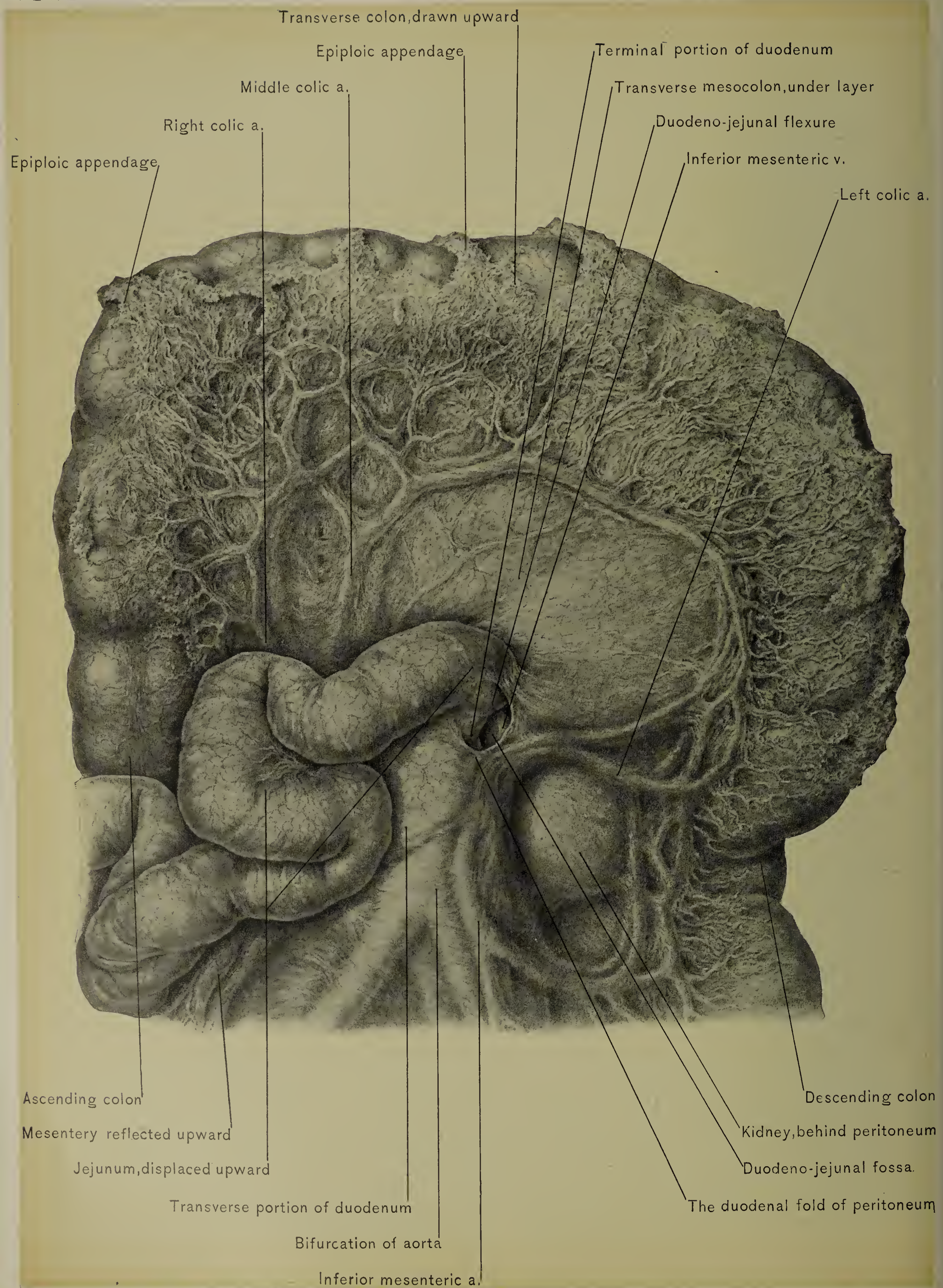
The **transverse meso-colon** is the broad fold of peritoneum connecting the transverse colon to the posterior wall of the abdominal cavity. In the adult it is formed, as has been shown, by the ascending or posterior layer of the great omentum. In the fetus, as previously described, the ascending layers of the great omentum pass over the transverse colon to the posterior wall of the abdominal cavity, where they separate at the lower border of the pancreas, one layer passing in front of the pancreas, as in the adult, while the posterior layer turns downward, reaches the transverse colon, which it surrounds, and then passes backward to the abdominal wall and descends to form the mesentery, as in the adult. In the fetus, therefore, both descending and both ascending layers of the great omentum lie in front of the transverse colon, while in the adult both descending layers and but one ascending layer lie in front of the transverse colon. In the adult the ascending layers of the great omentum have merged with the upper layer of the transverse meso-colon, making it practically one layer. The transverse meso-colon is continuous, through its under layer, upon each side with the ascending and the descending meso-colon. Between its layers pass the blood-vessels, lymphatics, and nerves supplying the transverse colon. It divides the abdominal cavity proper into two incomplete compartments—an upper and a lower; the upper compartment contains the liver, the stomach, and the spleen; and the lower, the intestines.

The **Phreno-colic Ligament** is a fold of peritoneum which passes from the splenic flexure of the colon beneath the spleen, to the under surface of the diaphragm, opposite the tenth and eleventh ribs. This ligament supports the spleen, the lower end of the organ resting upon it.

The **Epiploic Appendages** are pouches of peritoneum containing fat, and are attached here and there along the whole length of the large intestine except the rectum. They are situated chiefly opposite the inner muscular band, and are more numerous upon the transverse colon and sigmoid flexure. They are of value in distinguishing the large from the small bowel. Sometimes they are quite long. The author has known a long epiploic appendage that was infiltrated and discolored by inflammation, the origin of which was in the vermiform appendix, to be mistaken for the latter in an operation for appendicitis. An epiploic appendage may become adherent to a neighboring coil of intestine or to the parietal layer of peritoneum, producing a band which may cause intestinal obstruction.

The **Meso-cecum** is a double fold of peritoneum extending between the cecum and the floor of the iliac fossa, connecting the cecum with the latter. It is best developed in the first and second types of the cecum, and becomes less perceptible as the cecum approaches the fourth type. The right peritoneal layer of the meso-cecum connects the right side of the meso-appendix with the right layer of the ascending meso-colon, and the left layer connects the left peritoneal layer of the meso-appendix with the under layer of the mesentery. A well-developed meso-cecum in the fetal or second type of cecum may prevent delivery of the cecum through the incision in the abdominal wall in removal of the vermiform appendix.

The **Meso-sigmoid**, the continuation of the descending meso-colon, is the reflection of peritoneum connecting the sigmoid flexure with the posterior wall of the extreme lower portion of the abdominal cavity and with the posterior wall of the pelvic cavity. It extends from the termination of the descending colon in the iliac fossa, at the outer border of the psoas magnus muscle, to the commencement of the rectum, opposite the middle portion of the sacrum. In following the line of attachment of the meso-sigmoid it will be seen to cross the psoas magnus muscle and the iliac vessels near their bifurcation, and, after passing slightly to the right, to descend obliquely, reaching almost to the floor of the pelvis. The whole of the meso-sigmoid lies to the left of the median line. The width of the meso-sigmoid—the distance between the attachment to the parietes and to the bowel—varies from one to three and one-half inches (two to nine centimeters). The width of the meso-sigmoid permits the greater portion of the sigmoid flexure, when distended, to occupy the pelvic cavity, and, in many individuals, to extend



DUODENO-JEJUNAL FOSSA.

over into the hypogastric region. The terminal part of the meso-sigmoid, if much infiltrated by extensions of carcinoma of the sigmoid flexure, can be felt by introducing the finger into the rectum. Between the layers of the meso-sigmoid are the sigmoid artery or arteries and the superior hemorrhoidal artery, with their accompanying veins, and the lymphatic vessels and nerves supplying the sigmoid flexure.

The **Meso-rectum** does not exist, if the description of the rectum as given below be accepted. What is described in many of the text-books as the meso-rectum is here considered the terminal portion of the meso-sigmoid.

Peritoneal Fossæ.—In studying the course of the peritoneum, the various fossæ must be carefully observed. They are formed by folds and depressions of the peritoneum, are frequently absent, and are of importance because of their relation to certain pathologic conditions. Some of the viscera may become herniated through the intersigmoid and duodeno-jejunal fossæ. The fossæ around the cecum—namely, the ileo-colic, ileo-cecal, and subcecal fossæ—are associated with the vermiform appendix, and may hide an inflamed appendix or occasionally make it possible for the peritoneum to wall in an appendicial abscess. Through the inguinal fossæ, which have been previously described, inguinal herniæ pass.

The **intersigmoid fossa** is a depression sometimes present on the left side of that portion of the meso-sigmoid occupying the iliac fossa, and is situated between the anastomoses of the sigmoid arteries. At the bottom of this fossa, posterior to the peritoneum, lies the ureter. It varies in depth from one to one and one-half inches (two and one-half to four centimeters), and may be the site of a sigmoid hernia, of which three cases have been recorded.

Another fossa is occasionally present in the parietal portion of the peritoneum, where the continuation of the under layer of the mesentery passes to the descending colon, to form the internal layer of the descending meso-colon. The mouth of this fossa is broadened by a branch of the inferior mesenteric artery.

The **duodeno-jejunal fossa** is situated close to the left side of the fourth portion of the duodenum, near the duodeno-jejunal flexure. The fossa is formed by a fold of the posterior parietal peritoneum extending toward the right side of the body, to a vertical line on the anterior surface of the fourth portion of the duodenum. Its orifice is directed upward. Sometimes there is an additional ridge of peritoneum which is situated near the upper limit of the duodeno-jejunal flexure and deepens the fossa. According to Treves, the fossa is present in about forty-eight per cent. of cases, and admits the thumb up to the first joint. The fourth portion of the duodenum usually bulges against the peritoneal fold and closes the fossa. It gains importance from being the site of retro-peritoneal herniæ.

The **ileo-colic fossa** is a peritoneal pouch formed in front of the mesentery, at

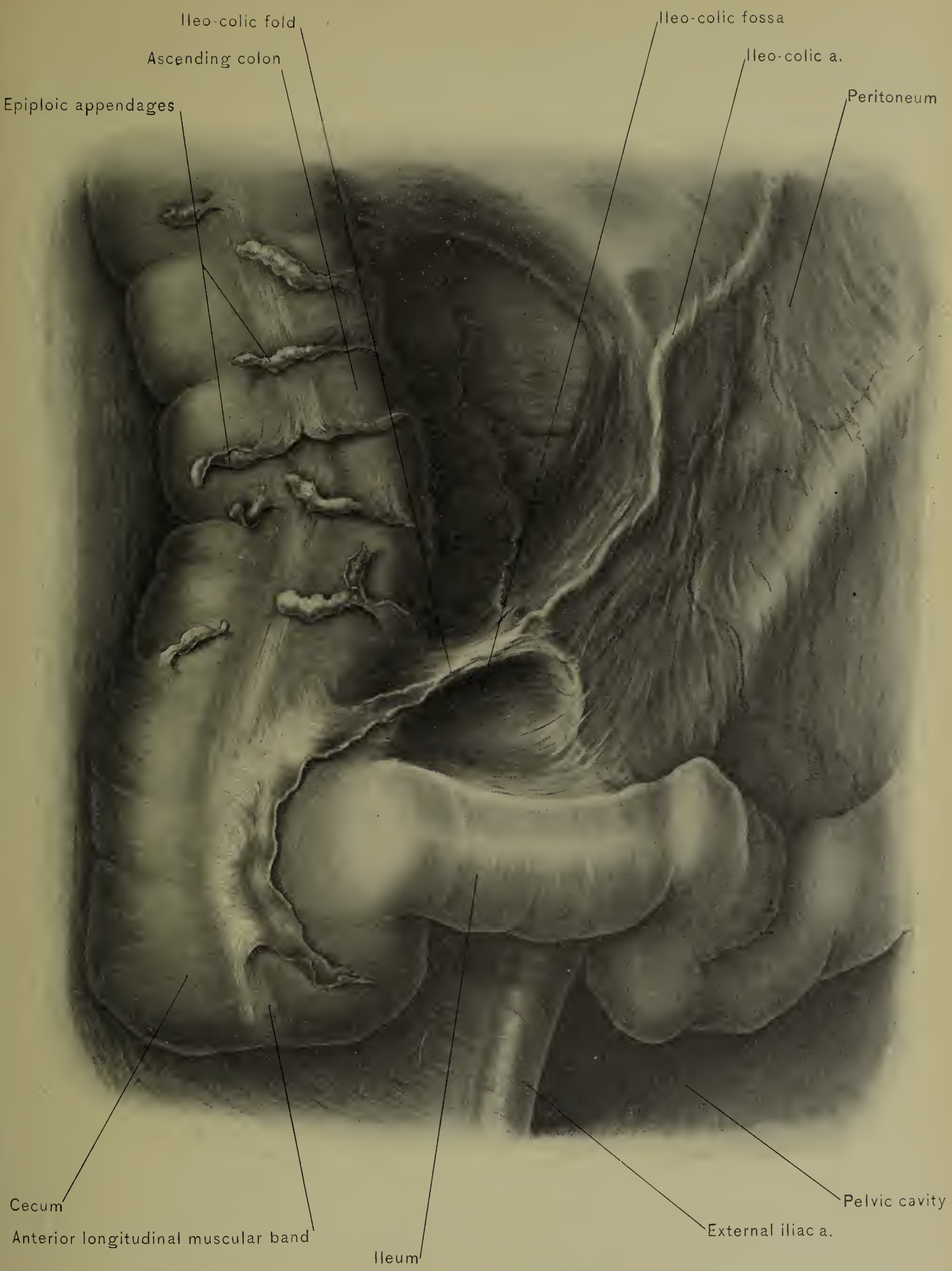
the angle of the junction of the ileum and colon. The floor is formed by the mesentery, and sometimes by a portion of the ileum. The ileo-colic fold of peritoneum forms its upper boundary; the ileum, its lower boundary; and the ascending colon, its outer or right boundary. This pouch varies in size and depth, and, being situated too high up, does not play an important part in appendicitis. The **ileo-colic fold** is a ridge produced by the colic branch of the ileo-colic artery.

The **ileo-cecal fossa** is a peritoneal pouch, situated beneath or behind the mesentery, at the angle of the junction of the ileum and cecum. To expose it, both the ileum and the cecum must be displaced upward and forward. It is bounded on the right by the inner layer of the meso-cecum and meso-appendix, and on the left by the under surface of the mesentery. The roof is formed by the **ileo-cecal fold**, a thin fold of peritoneum extending from the free border of the ileum to the cecum, and finally joining the surface of the meso-appendix. This fossa may be very deep and long, at times extending upward behind the ascending colon as far as the right kidney and duodenum. The appendix is often found in the ileo-cecal fossa, which explains why this location is often the site of the products of appendicitis. For this reason a knowledge of the ileo-cecal fossa is important.

The **subcecal fossa**, as its name implies, is immediately under the cecum, so that this portion of the bowel must be raised in order to obtain a view of it. It is the recess beneath the cecum external to the meso-appendix and meso-cecum. When there is a ridge in the peritoneum where the outer layer of the meso-cecum is continuous with the corresponding layer of the ascending meso-colon, the fossa is more definitely limited externally. On account of its high position it does not play a prominent part clinically.

The appendix may occupy any one of these three fossæ in relation with the cecum, but most often it is found in the ileo-cecal or the subcecal fossa. On account of the various complications which may arise if the appendix occupy any of these fossæ, the operator may be led to form an incorrect conception of the true condition. Thus, at times, the vermiform appendix might constitute a retro-peritoneal hernia; or, if the appendix should occupy one of these fossæ and the mouth of the fossa close over the organ, the organ might be supposed absent. Suppuration around an appendix so walled in would be entirely circumscribed.

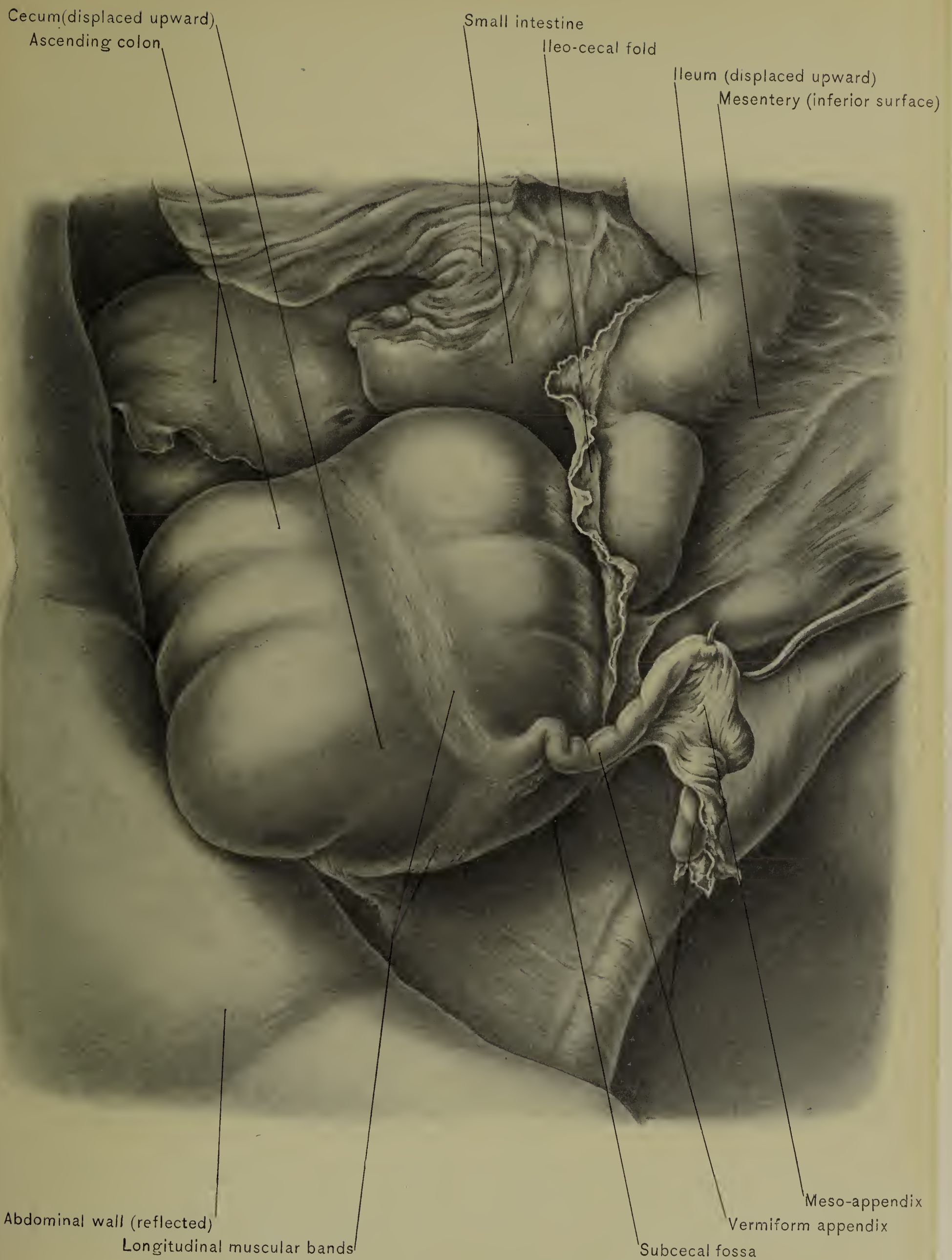
Relations of the Abdominal Viscera.—Having traced the course of the peritoneum, the natural positions of the viscera, their situation, their connections with the neighboring parts and the relation they bear to the surface marks of the body should next be studied. To become thoroughly familiar with the relations the viscera bear to the surface of the abdominal wall, the reflected portions of the latter should be replaced in position, and the parts then be examined.



ILEO-COLIC FOSSA.



ILEO-CECAL FOSSA.



The Liver.—The larger portion of the liver is found in the right hypochondriac region, although the organ also occupies part of the epigastric, and may extend into the left hypochondriac region; it seldom extends more than two inches (five centimeters) beyond the left margin of the sternum. Its bulk entirely fills the antero-posterior diameter of the abdominal cavity in this location. In the infant the liver is proportionally much larger than in the adult. Its superior and posterior surfaces are in close contact with the under surface of the diaphragm, from which the organ is suspended; therefore the liver, and tumors attached to it, move upward and downward with that muscle during respiration. The right lobe of the liver is protected by the chest-wall, while the left lobe extends across the epigastric region just below the xiphoid cartilage, where it lies behind the anterior abdominal wall. The outline of the liver, as drawn on the surface of the body, is described with the surface anatomy of the abdomen, and may now be demonstrated by the dissector. When the subject assumes the upright position, the lower limit of the organ drops about one-half inch (one centimeter). Owing to its friability and because of the fact that it fills the antero-posterior diameter of the abdominal cavity, the liver is more frequently ruptured than is any other viscus. This accident is followed by profuse hemorrhage and death. The hemorrhage is copious, because the hepatic veins or their radicles must be torn, since their walls are adherent to the tissue of the liver. These vessels empty into the inferior vena cava, are short, contain no valves, and are always held open by the surrounding hepatic tissue. Torn radicles of the portal vein and branches of the hepatic artery add to the severity of the hemorrhage. From its relation to the chest-wall it will be seen that one of the lower ribs, when fractured, may penetrate the liver. This organ, when enlarged, encroaches upon the abdominal cavity. Tumors of its lower surface also descend in that cavity, while those arising upon its upper surface infringe upon the thoracic cavity. Tight lacing alters the shape of the liver and pushes its anterior margin downward. Collections of fluid in the right pleural cavity also depress this organ, and in collapse of the lung or gaseous distention of the intestines (tympanites) it is elevated.

The liver is in relation above with the diaphragm and the anterior abdominal wall. Below it are the stomach, the lesser omentum, the gall-bladder, the hepatic flexure of the colon, the right kidney, and the first and second portions of the duodenum. Behind it are the lower end of the esophagus, the right suprarenal capsule, the aorta and inferior vena cava, the crura of the diaphragm, the tenth and eleventh thoracic vertebræ, and the structures just mentioned as being below it. In front of it are the diaphragm and the anterior abdominal wall.

The relations of the liver show that abscesses of its upper surface may ulcerate through the diaphragm, and the pus thus enter the lung and be

expectorated. Abscesses of its lower surface may open into the transverse colon, stomach, or duodenum. The walls of the abscess at times become adherent to the abdominal parietes, and the pus may find its way to the surfaces of the body.

The organ is held in place by five **ligaments**; they are the round, the suspensory, the right and the left lateral, and the coronary, the first consisting of the obliterated umbilical vein, the others being reflections of the peritoneum. These ligaments can be readily studied with the organ *in situ*.

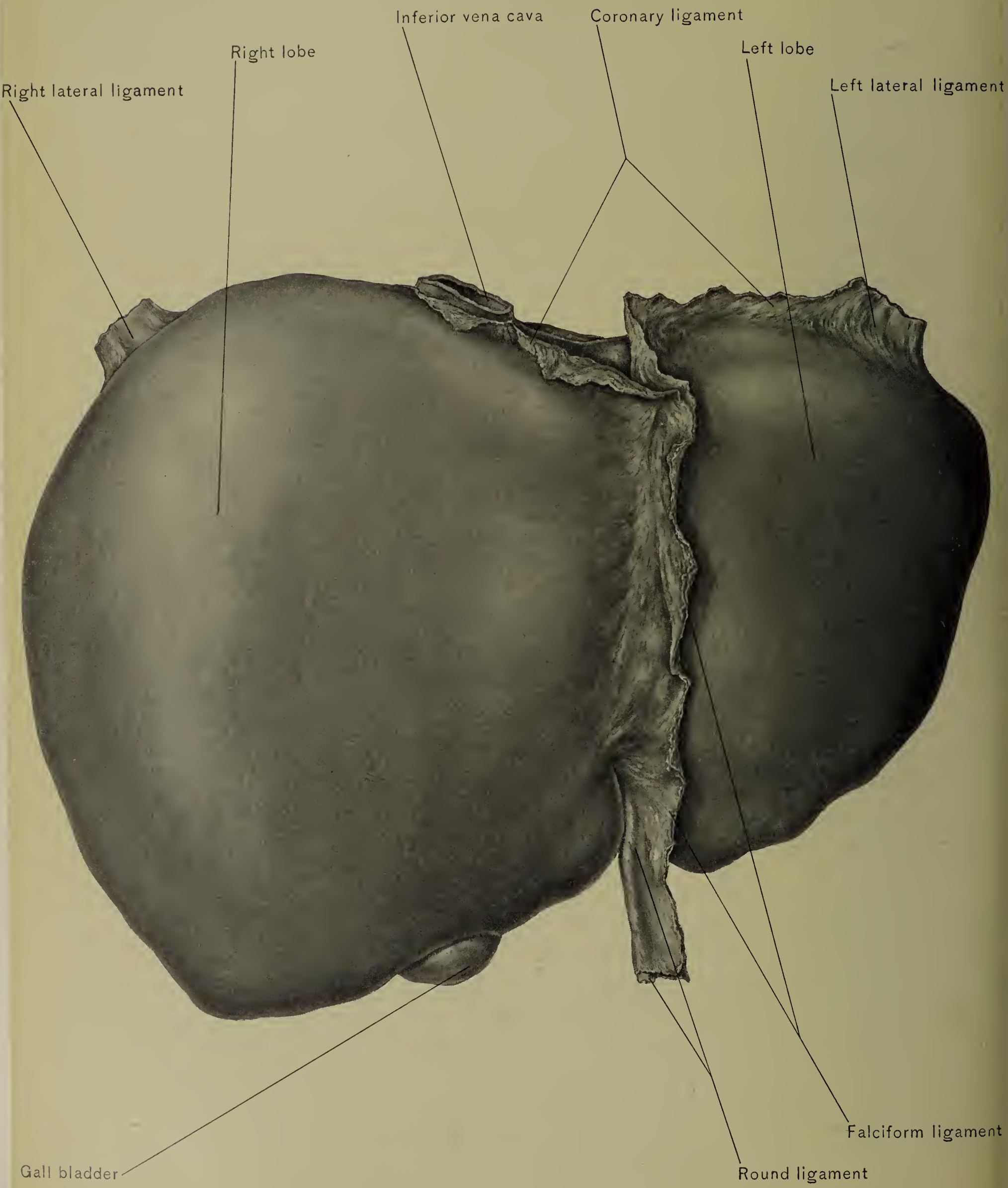
The **round ligament of the liver** (ligamentum teres) is the fibrous remnant of the umbilical vein of the fetus. It extends from the umbilicus to the under surface of the anterior margin of the liver, along the anterior division of the longitudinal fissure, to the transverse fissure; thence it passes to the inferior vena cava as the remains of the ductus venosus. Between the umbilicus and the anterior margin of the liver it is held in the free margin of the suspensory ligament of the liver.

The **suspensory ligament of the liver** (falciform or broad ligament) consists of a double peritoneal fold, the free margin of which envelops the round ligament. It is attached to the diaphragm and the anterior abdominal wall as far downward as the umbilicus, and to the superior surface of the liver, from the notch in the anterior border, at the longitudinal fissure, to the posterior surface. Behind it becomes continuous with the anterior layer of the coronary ligament.

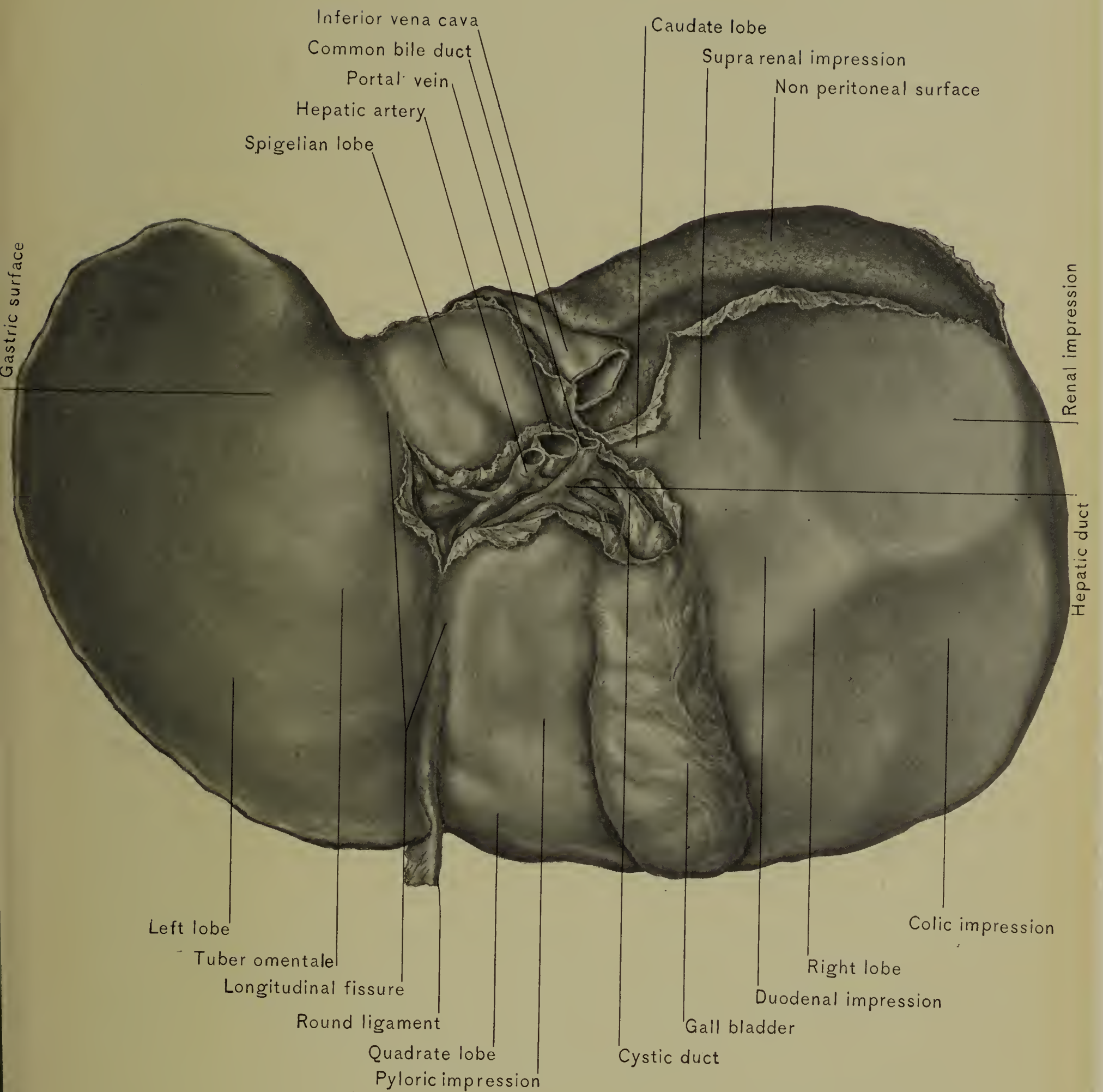
The **coronary ligament of the liver** consists of two layers of peritoneum which are reflected from the posterior surface of the liver to the diaphragm. These two layers are separated by an interval which is filled with areolar tissue, and which leaves part of the posterior surface devoid of peritoneal covering. At each end of the posterior surface are the **right and the left lateral ligament**, which are merely continuations of the coronary ligament. In addition to the ligaments it must be remembered that the inferior vena cava assists in holding the liver in place, for this large vessel passes nearly vertically upward in a groove on the posterior surface of the liver for a distance of about two and one-half inches (six centimeters), and is firmly adherent to the hepatic tissue. It may even be covered by liver tissue, such processes being called *pons hepatis*. It is also supported by bands of fibrous tissue passing from the nonperitoneal portion of the posterior surface of the liver to the diaphragm, and also by intra-abdominal pressure.

On account of the firmness with which these ligaments hold the liver in position it is well to delay the study of its surfaces, borders, and fissures until it has been removed from the abdominal cavity.

The **Gall-bladder** is seen in contact with the under surface of the right lobe of the liver. Its fundus is situated opposite the right ninth costal cartilage, or the



SUPERIOR SURFACE OF LIVER.



angle formed by the right costal margin and the right margin of the right rectus muscle. Its long diameter extends antero-posteriorly. The fundus is the lowest portion of the gall-bladder with the body in the erect posture, and the bile therefore flows into this receptacle, especially when the stomach is empty. The fundus of the gall-bladder sometimes extends for a distance of an inch and a half (four centimeters) beyond the anterior border of the liver; at other times it does not project beyond the border of the liver. When the gall-bladder projects beyond the anterior margin of the liver, it is, of course, more readily accessible for operative interference and can be more easily drawn into the abdominal wound. The organ may in rare cases be congenitally absent, or may become obliterated as the result of disease.

Gall-stones are usually formed within the gall-bladder, and may remain for years without giving rise to pronounced symptoms. In passing out, a gall-stone may produce severe colic in traversing the cystic and the common bile duct. If the stone lodges in the cystic duct, drainage from the gall-bladder is prevented, so that bile can not enter and mucus secreted within can not pass out. The suspension of drainage favors ulceration of the gall-bladder, so that the stones may escape by way of the adjacent transverse colon or the duodenum, may enter the abdominal cavity, or pass out through the abdominal wall. Obstruction of the cystic duct from any cause may be followed by great distention of the gall-bladder, produced by its mucous secretion. This condition is relieved by opening the gall-bladder (cholecystotomy), suturing it to the abdominal wall (cholecystorrhaphy), and draining it. If a stone is present in the cystic duct, it should be removed. External violence applied to the gall-bladder when it is distended may rupture it, and the escaped contents may give rise to peritonitis.

The **Stomach**, the most dilated part of the alimentary canal, is situated in the left hypochondriac and the epigastric region, between the esophagus and the small intestine, and is retained in position by the esophagus and by reflections of the peritoneum. The more capacious extremity of the stomach, which is directed toward the left side of the body, is the **cardiac end**; the narrow extremity, which is directed toward the right side, is the **pyloric end**; and the intermediate portion is the **body of the stomach**. The portion of the cardiac end projecting to the left beyond the esophagus is the **fundus**, or **great culdesac**, of the stomach, and the slight dilatation of the stomach at the pyloric end is the **antrum of the pylorus**, or **lesser culdesac**. The stomach has an anterior and a posterior surface; these surfaces are somewhat crescentic in shape. The upper and shorter margin of the stomach is the **lesser curvature**, and its lower and longer border is the **greater curvature**.

The part of the stomach occupying the left hypochondriac region is the

cardiac end and the body, three-fourths of the organ lying in that region. The portion of the stomach occupying the epigastric region is the pyloric end ; it is in contact with the under surface of the liver and is continuous with the duodenum.

The folds of the peritoneum that are attached to the stomach and serve to connect it with surrounding structures are the gastro-colic, the gastro-hepatic, and the gastro-splenic omenta and the gastro-phrenic ligament.

The **gastro-colic** or **great omentum** connects the lower convex border or greater curvature of the stomach with the transverse colon, and is prolonged downward over the small intestine.

The **gastro-hepatic** or **lesser omentum** connects the upper concave border or lesser curvature of the stomach with the transverse fissure of the liver.

The **gastro-splenic omentum** connects the cardiac end of the stomach with the hilum of the spleen.

The **gastro-phrenic ligament** is situated on the left side of the esophagus, and connects the fundus of the stomach with the diaphragm.

RELATIONS.—In front of the stomach are the diaphragm, anterior abdominal wall, and liver. Behind it are the spleen, pancreas, left kidney, left suprarenal capsule, transverse meso-colon, diaphragm, aorta, inferior vena cava, and solar plexus. Above it are the diaphragm, liver, and lesser omentum. Below it are the transverse colon, great omentum, and spleen.

The stomach is subjected to frequent alterations in position, depending upon the variation in the size of the surrounding organs, upon the accumulation of fluid in the chest or in the abdomen, upon respiration, upon pressure from without, as by tight lacing, and upon the quantity of food it contains. When the stomach is greatly distended, it carries the transverse colon and the small intestine downward, and produces a prominence below the ensiform cartilage, where normally a depression (*scrobiculus cordis*) exists ; at the same time it forces the liver, diaphragm, and heart upward. Distention of the stomach causes it to encroach upon both heart and lungs ; this sometimes occurs after a heavy meal. The action of the heart is retarded when that organ is pushed upward and to the right, so that the capillaries of the brain and of the head are full of venous blood, thus disturbing the cerebral circulation and flushing the face. Consequently persons predisposed to apoplexy are likely to have the “stroke” immediately after eating a heavy meal. When the stomach is distended, its shape and size may be outlined by percussion.

The stomach may be displaced downward in cases of large omental hernia, and the greater curvature may even descend into the pelvis in dilatation due to stricture of its pyloric end. As it is free from attachment, except by peritoneum, the pyloric end is more movable than the cardiac end, so that the pyloric

portion of the stomach is more readily displaced downward by tumors of the stomach. Owing to the close relation borne by the stomach to the heart, pain in the former is frequently referred to the latter, since on the left side of the esophagus the heart is separated from the stomach only by the diaphragm. Because of the proximity of the stomach and heart, painful affections of the one may be mistaken for disease of the other, so justifying the advice that "if the patient complain of his stomach, suspect heart disease; if he complain of his heart, suspect indigestion."

A distended stomach will cause dyspnea by pressing upon the lung and heart, thus interfering with their action. Pain in the region of the spleen, cardiac end of the stomach, or base of the left pleural cavity may be so confusing that a positive diagnosis can not at once be made. A moderately distended stomach has its contained gas only in the cardiac end, which is its highest part when the body is in the upright position. In many this is constantly present, and would yield a resonant sound over the base of the left lung even if considerable fluid were in the bottom of the pleural sac. This is an awkward complication, because the upright position, which sends the gas upward, drives the fluid downward, so that they overlap, and one masks the other. The only remedy is to place the patient in a position which will cause the gas and liquid to diverge.

The close proximity of the heart to the stomach is illustrated by a case in which a thorn half an inch long had been swallowed and had found its way into the cavity of the right ventricle through the diaphragm and the pericardium (Treves).

When the stomach is empty, its upper concave border or lesser curvature is directed upward, its lower convex border or greater curvature downward, and the pylorus behind the linea alba, about three inches (seven centimeters) below the ensiform cartilage. When the stomach is distended, the upper border is directed backward and the lower forward, and the pylorus approaches the right semilunar line. Adhesions between the stomach and adjacent coils of intestine may give rise to colic and other disturbances of the gastro-intestinal tract.

Injuries of the stomach.—The stomach is much more exposed to injury when full than when empty. Wounds of the stomach are more dangerous if inflicted on this organ when it is full, as its contents escape into the peritoneal cavity and set up acute peritonitis. When empty, the stomach is but slightly exposed to injury, as it lies well back in the abdominal cavity, against the posterior abdominal wall. There are cases recorded in which the stomach has been wounded and recovery has followed, leaving a gastric fistula that offered an opportunity for physiologic experimentation.

The portion of the stomach which is immediately behind the abdominal wall

is accessible for operative interference, and is located by a triangle, bounded on the right by the anterior margin of the liver, on the left by the cartilages of the eighth and ninth ribs and below by a horizontal line passing between the tips of the tenth costal cartilages; the latter line corresponds nearly with the lower border when the organ is not much distended. To expose the stomach, one of three incisions may be made—namely, parallel to and about two fingerbreadths from the free border of the left costal cartilages; through the linea alba; or along the left semilunar line.

Gastrotomy—cutting or opening the stomach—is performed for the removal of a foreign body or for digital dilatation of the pylorus when the site of a cicatricial stenosis of the pylorus can be reached with the finger introduced through the opening in the stomach (Loreta's operation). Digital dilatation of the pylorus in cicatricial stenosis is but seldom done at present, the operation of pyloroplasty having supplanted it. Pyloroplasty is done by cutting through the anterior wall of the pylorus, the incision dividing the stricture and extending an inch (two and one-half centimeters) into both the stomach and the duodenum. The margins of the wound thus made are retracted, and the edges are apposed in a direction at a right angle to that of the incision, the sutures being passed parallel with the long axis of the stomach. In this manner a longitudinal incision is made to look like a sutured wound extending across the pylorus. Another operation performed on the stomach is that of gastrostomy—the establishment of a gastric fistula for the purpose of introducing food into the stomach in obstructive disease of the esophagus. This operation may be done by two stages, the first operation consisting of exposing the organ and anchoring it to the anterior abdominal walls. This is known technically as *gastrorrhaphy*. The second step of the operation consists of making the incision into the stomach. In another operation, devised by Witzel, a rubber catheter or tube is introduced into a small opening in the anterior wall of the stomach, and from two to two and a half inches (five to six centimeters) of the projecting portion of catheter are buried by folding over it two plaits of the stomach-wall. The stomach, after being replaced, is then sutured to the parietal peritoneum, and the abdominal wound closed, except at the site of the catheter. *Pylorectomy*—excision of the pylorus—is another operation performed upon this viscus. In this operation the stomach is exposed through a median incision and drawn out of the abdomen. The duodenum and stomach are then clamped at the point of selection, and the greater and the lesser omentum are divided and ligated. The diseased pylorus is then cut away, and the intestine united to the stomach.

Gastrectomy, or removal of the stomach, is occasionally resorted to for carcinoma in cases in which the disease is limited to that organ. In this operation

the esophagus and the duodenum are clamped, the stomach is removed, and the duodenum, or a loop of jejunum, and the esophagus are united. Gastro-enterostomy is the establishment of a communication between the stomach and the intestine, preferably the upper portion of the jejunum. This operation is performed in cases of advanced carcinoma of the pylorus. In both gastro-enterostomy and pylorotomy the stomach is attacked preferably through the linea alba.

The arteries which supply the stomach are the pyloric branch of the hepatic, coronary branch of the gastric, right gastro-epiploic, left gastro-epiploic, and the vasa brevia branches of the splenic artery. The pyloric and coronary arteries anastomose along the lesser curvature; the two gastro-epiploic arteries, along the greater curvature; the vasa brevia supply the cardiac end of the stomach. These arteries can frequently be seen through the peritoneum covering them.

The **lymphatics of the stomach** run chiefly along the curvatures between the layers of the omenta, and around the cardiac and pyloric extremities of the organ. They arise in the subserous and submucous coats, and are divided into three sets, accompanying corresponding blood-vessels: one set extends along the lesser curvature, collecting from both walls, and entering the pyloric glands; another set extends along the greater curvature, receiving from both walls, and ending in one of the main lacteals at the root of the mesentery; and a third set passes off the cardiac end, along the vasa brevia, to the splenic lymphatic glands.

The **Spleen** is found in the left hypochondriac region, though the upper and inner end is in the posterior part of the epigastric region. With the abdominal viscera in their normal positions the spleen can not be seen in the dissection, as it is covered by the stomach and the left ribs and costal cartilages. By drawing the stomach to the right and passing the hand beneath the diaphragm and costal wall, the spleen can readily be felt and drawn into view. It occupies an oblique position in the abdominal cavity, its upper end being nearer the median line than the lower end. Anteriorly the spleen extends to the midaxillary line. At times, and within the limits of health, it reaches to the anterior axillary line. When, by percussion, it is determined that the spleen extends beyond the anterior axillary line, it may safely be said that the organ is enlarged. It lies opposite the ninth, tenth, and eleventh ribs, but is separated from the chest-wall by the peritoneum and diaphragm, and in part by the left pleura and lung. It is an exceedingly vascular, ductless organ, and is the largest of the so-called ductless or blood glands. It weighs about seven ounces (200 grams), is oblong in shape, and measures from four to five inches (ten to twelve centimeters) in length, three to four inches (seven to ten centimeters) in width, and about an inch (two and one-half centimeters) in thickness. The spleen is enveloped by two coats or coverings—a peritoneal and a

fibro-elastic coat. The peritoneal covering invests it very closely, being adherent to the underlying fibro-elastic coat, and can be removed only with difficulty. The immediate covering of the spleen is fibro-elastic in character, and is so arranged that it can not possibly be removed without destroying some of the gland tissue. Besides being very adherent to the organ, this tunic sends prolongations or trabeculæ into the gland substance. The reflection of peritoneum passing from the splenic flexure of the colon to the diaphragm and supporting the spleen is known as the phreno-colic or suspensory ligament of the spleen; that passing from the hilum of the spleen to the stomach is called the gastro-splenic omentum; and that passing from the hilum to the front of the left kidney, the lieno-renal ligament.

The spleen has three surfaces—the phrenic, the gastric, and the renal.

The **phrenic, posterior, or external surface** is convex, and lies against the diaphragm, opposite the ninth, tenth, and eleventh ribs. The inner aspect of the organ is divided into two distinct concave surfaces by a sharp ridge and a groove, the *hilum*, through which the vessels, nerves, and lymphatics of the spleen pass. The larger of these divisions is known as the **anterior or gastric surface**, and is in relation with the cardiac end of the stomach, the splenic flexure of the colon, and the tip of the tail of the pancreas. The **inner or renal surface** is the smaller division, and rests upon the left kidney.

The wedge-shaped outer edge of the base of the left lung descends between the upper portion of the spleen and the ribs. Left thoracic tumors or intrathoracic accumulations, as pleural effusions, pneumothorax, or emphysema, may push the spleen downward; on the other hand, intra-abdominal accumulations of gas or fluids or abdominal tumors may push it upward.

The spleen does not descend below the chondral margin, even after deep inspiration; in the adult the normal spleen can not be felt. When much enlarged, as in leukemia and in malaria, its anterior notched edge may at once be detected. A hypertrophied spleen may weigh eighteen or twenty pounds (eight or nine kilograms).

Splenectomy—removal of the spleen—is not performed in leukemia, because it is almost certain to be followed by death from hemorrhage. The operation may, however, be performed for tumors, wounds, abscess, or cysts of the organ or when it is movable or floating. Wounds of this organ are likely to be fatal from hemorrhage; but if the wound is very small, contraction of the fibro-elastic coat may close it and check the bleeding. Rupture of a normal spleen seldom occurs, because of its mobility and the protection afforded by the chest-wall. But when the organ is enlarged, it may be ruptured by either muscular or external violence. This accident is followed by death from hemorrhage. When one of the left lower ribs is fractured it may pierce the diaphragm and enter the spleen.

The **vessels and nerves of the spleen** reach that organ by passing behind the pancreas and then between the two layers of the lieno-renal ligament. The splenic artery breaks up into branches just before it reaches the hilum. These branches receive an investment from the fibro-elastic tunic of the organ and do not anastomose. The arteries terminate and the veins begin in open extremities in the pulp of the organ. The venous radicles unite and form the splenic vein, which is larger than the artery. The splenic vein joins the superior mesenteric vein to form the portal vein. The nerve supply is derived from the solar plexus and the right pneumogastric nerve, filaments from which follow the splenic artery and its branches.

The **lymphatics of the spleen** are found at its hilum, where they receive the superficial and deep lymphatics—that is, from the surface and interior of the organ, respectively. After passing through several glands along the course of the splenic artery they terminate in the celiac glands.

The **Small Intestine** commences at the pyloric end of the stomach, and terminates in the right iliac region, at the junction of the cecum with the colon. Its length is variable. In the male the average length of the small intestine is twenty-two and one-half feet (6.86 meters), the extremes being fifteen feet and six inches (4.75 meters) and thirty-one feet and ten inches (9.70 meters). Its length in the female is greater, the average being twenty-three feet and four inches (7.11 meters), the extremes being nineteen feet and ten inches (six meters) and twenty-nine feet and four inches (nine meters).

Position of the small intestine.—The coils of the small intestine occupy no certain fixed position in the abdomen; in the fetus, however, and during the earlier part of extra-uterine life, they are in greater part situated to the left of the middle line, on account of the large size of the liver at this time of life. The following description of the arrangement of the coils of the small intestine in the adult is after that of Mr. F. Treves, who has given this subject careful and personal attention. Starting from the duodenum, the gut first occupies the contiguous parts of the left side of the epigastric and umbilical regions; the coils then fill some part of the left hypochondriac and lumbar regions; they now commonly descend into the pelvis, reappear in the left iliac quarter, and then occupy, in order, the hypogastric, lower umbilical, right lumbar, and right iliac regions. They then descend again into the pelvis, finally to reappear in the right iliac region. The coils of small intestine occupying the pelvis are those most likely to become involved and adherent in cases of pelvic peritonitis, which is frequently caused by inflammatory conditions of the uterine appendages. The coils may also be confounded with diseased tubes or ovaries, or with a cyst of the broad ligament. The coils of the small intestine which occupy the pelvis are

those most likely to form the contents of an obturator, sciatic, pudendal, or perineal hernia. The number of coils occupying the pelvis of the adult male depends upon the degree of distention of the bladder and rectum; in the female, largely upon the size of the uterus. In cases of pelvic tumor the number of coils occupying the pelvis is smaller in proportion to the size of the tumor.

Intestinal obstruction.—The lower portion of the small intestine is the part usually involved in acute mechanical internal intestinal obstruction, caused by bands or by holes in the mesentery, and producing a variety of internal or concealed strangulated hernia.

The small intestine consists of three portions; these are the duodenum, jejunum, and ileum.

The **duodenum** can not now be studied satisfactorily without dissecting the posterior parietal peritoneum, as it lies deeply throughout the greater part of its extent, and, therefore, its examination will be deferred.

The **jejunum**, the second portion of the small intestine, commences at the point where the small bowel abruptly turns downward, upon the left side of the second lumbar vertebra, which is also the point where the mesentery begins, and which marks the termination of the fourth portion of the duodenum.

The **ileum**, the third portion, has no fixed point of origin. It terminates at its junction with the cecum. The jejunum comprises about two-fifths, and the ileum three-fifths, of the small intestine, there being, however, no definite point where the jejunum can be said to end and the ileum commence. The jejunum and ileum are fixed to the posterior wall of the abdominal cavity by the mesentery, which has been described with the peritoneum.

The jejunum and ileum are protected anteriorly only by the great omentum and abdominal wall, and are therefore much exposed to injury. They are so freely movable that they are rarely contused. Small punctured wounds are not followed by the escape of septic matter into the peritoneal cavity, because of the intra-abdominal pressure, contraction of the muscular coat of the bowel, and plugging produced by protrusion of the mucous membrane. Nature attempts to close larger wounds in the same manner, and the occlusion may be completed by the exudation of lymph and adhesion of adjacent peritoneum upon a coil of intestine or the great omentum. Involvement of the jejunum, as in hernia, intestinal obstruction, or wounds, is more serious than a similar condition of the ileum, because the functions of the bowel are more important for the nutrition of the body as the stomach is approached. The jejunum is distinguished from the ileum by its slightly greater caliber (one-fourth inch—six millimeters—greater) and its thicker walls, made so by the *valvulæ conniventes*, which nearly disappear in the lower part of the ileum. Wounds of the small intestine are treated by suturing

them in such a manner as to bring the serous surfaces into contact, after which they quickly adhere.

DISSECTION.—The great omentum and transverse colon should be displaced upward, and the coils of the small intestine to the right. This exposes to view the junction of the duodenum and the jejunum on the left side of the vertebral column, opposite the second lumbar vertebra. The jejunum makes a sharp bend from this junction, thus forming the **duodeno-jejunal flexure**. The coils of intestine should next be displaced to the left, and the termination of the ileum in the cecum examined.

Meckel's Diverticulum, the remains of the vitello-intestinal duct, is a process or diverticulum occasionally springing from the lower part of the ileum, from one to three feet (thirty to ninety centimeters) from the termination of the ileum. It is usually a diverticulum or cord a few centimeters long, but it may extend to the umbilicus as a cord or as a duct which may give rise to an umbilical fecal fistula. When it extends to the umbilicus or becomes adherent to an adjacent peritoneal surface, it forms a band beneath which a loop of small intestine may be caught and strangulated.

The **Large Intestine**, the terminal part of the alimentary tract, consists of the cecum, colon, and rectum. Its average length in the male is four feet, eight inches (1.42 meters), and in the female, four feet, six inches (1.37 meters), the extremes being three feet, three inches (one meter), and six feet, six inches (two meters).

The **cecum** (caput coli), the commencement of the large intestine, is that part of the large bowel which lies below its junction with the ileum. It is about two and one-half inches (six centimeters) long, and somewhat smaller in diameter. It rests upon the extraperitoneal connective tissue and the iliac fascia, which covers the iliac and psoas muscles. Its most dependent point, or apex, projects just beyond the inner edge of the psoas magnus muscle, and is opposite a point a little to the inner side of the middle of Poupart's ligament. The cecum may hang over the iliac vessels and ilio-pectineal line, and occupy the cavity of the pelvis. After the second month of intra-uterine life the cecum gradually recedes from the region of the umbilicus, its original position, and finally becomes fixed in the right iliac fossa. The nondescent of the cecum is not so frequent as is generally supposed. The long axis of the cecum is not in a straight line with the axis of the ascending colon, but is somewhat oblique, inclining to the left from above downward. The cecum may occupy the sac of a right inguinal or femoral hernia.

The *topographic anatomy of the cecum*, particularly with reference to its relation to the extraperitoneal connective tissue in its immediate neighborhood, as well as to the large vessels in its vicinity, is of importance in connection with the treatment of inflammatory lesions of the vermiform appendix. A knowledge of

the relation of the postperitoneal connective tissue is of special importance for a correct understanding of those cases of appendicial abscess in which the appendix is only partly covered by peritoneum, and in which the perforation opens into the interval between the layers of the meso-appendix. A collection of pus thus formed in the postperitoneal connective tissue may make its escape by following the sheath of the iliac muscle to the front of the thigh.

The **vermiform appendix** is a narrow, musculo-membranous tube ending in a blind extremity, and is the lower end of the cecum which failed to grow as fast as the remainder of the cecum. It is present only in man and some of the higher species of apes; in other mammalia an elongated cecum is found. The appendix is usually attached to the inner and posterior wall of the cecum, the point which was originally the apex of the latter.

The cecum is found to be one of four *types*, and in each of these the appendix arises in a different manner. In the fetal type the appendix is the narrow lower end of the conic cecum, the apex of the cone being continued into the appendix. In the second type the cecum consists of two equally large sacculi at its lower end. In this type the appendix arises from the end of the cecum, between the sacculi, which are separated by the anterior longitudinal band. In the third type the external sacculus is of large size, the internal one being small, thus bringing the base of the appendix nearer the ileo-cecal valve. In addition the anterior wall of the cecum grows more rapidly than does the posterior, so that the root of the appendix is attached to the posterior surface of the cecum. In the fourth type the internal sacculus has disappeared entirely, and the base of the appendix is attached to the posterior wall of the cecum behind the junction of the ileum and cecum.

In cases of nondescent of the cecum the appendix will hold a corresponding abnormal position; under such circumstances it may even lie to the left of the median line. Lennander mentions the case of a boy of sixteen in whom the cecum and the appendix, which was nine inches (twenty-two centimeters) long, were found in the left hypochondriac region, lying against the spleen.

The appendix varies in length from one-half to nine inches (one to twenty-three centimeters), the average length being from three to four inches (eight to ten centimeters). When the appendix is long, the cecum is, as a rule, small. Its diameter is that of a goose quill, or one-eighth to one-fourth inch (three to six millimeters). It is hollow, and has an opening of communication with the cecum, which is usually guarded by a valve of mucosa.

Position of the vermiform appendix.—The base or root of the vermiform appendix is usually attached to the postero-internal aspect of the cecum, just below the junction of the ileum with the cecum. The location of this portion of

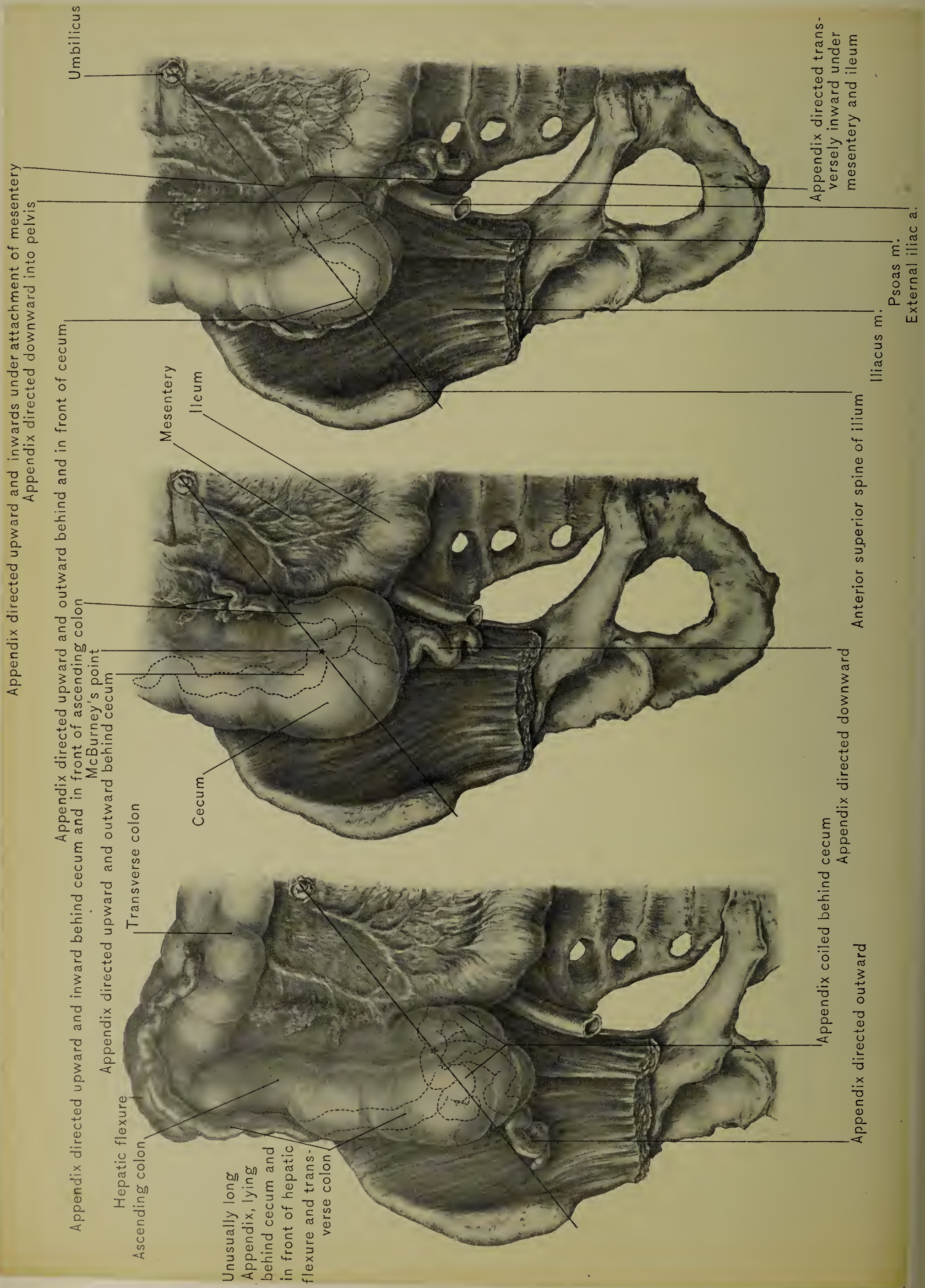


DIAGRAM OF POSITIONS OF THE VERMIFORM APPENDIX.

the appendix varies much less than does that of the remainder of the organ. Usually the base of the appendix is nearly opposite **McBurney's point**, which is situated midway between the umbilicus and the anterior superior spine of the ilium; consequently in appendicitis tenderness on pressure can be detected most constantly at this point. Tenderness may be most marked, however, at a point some distance from this place, as the terminal part of the appendix may hold one of several positions. As previously stated, the position of the root of the vermiform appendix varies but slightly. The remaining and more movable portion of the organ may take any one of several directions or positions: (1) It may be directed upward or upward and outward, lying in front of, behind, or upon the inner or outer side of the cecum and ascending colon; (2) it may be directed under the mesentery, and upward and inward, inward, or downward and inward over the brim of the pelvis; (3) it may be coiled upon itself under the cecum; (4) it may be directed downward, and lie free under the cecum; (5) it may be directed outward, lying in front of or behind the cecum.

The appendix may occupy the ileo-colic, ileo-cecal, or subcecal fossa, but it is most frequently found in the ileo-cecal fossa. When it occupies a deep ileo-cecal or subcecal fossa which has become closed by local peritonitis, there occurs practically a retro-peritoneal hernia of the appendix. Again, if it occupies one of these fossæ and the mouth of the fossa closes over it, it might be regarded by the operator as absent. Suppuration due to inflammation of an appendix so walled in would be circumscribed. Among the uncommon positions held by the appendix are: (1) Behind the peritoneum, below the cecum, adherent to the under surface of the cecum and in contact with its muscular wall, and covered by its peritoneal coat; (2) adherent to the peritoneum along the right border of the cecum and ascending colon; (3) adherent to the peritoneum at any point in the neighborhood of the cecum; or (4) in the inguinal canal.

When the appendix is directed upward or upward and outward, and lies behind or upon the outer side of the cecum, an abscess resulting from disease of the appendix frequently produces its local manifestations in the loin and simulates abscess of hepatic or renal origin. When the inflamed organ is directed downward or downward and inward into the true pelvis, irritation of the bladder or ovaries may ensue.

The **colon**, the second portion of the large intestine, consists of three portions—the ascending, transverse, and descending; it makes three bends or flexures—the hepatic, splenic, and sigmoid.

The **ascending colon**, the average length of which in the adult is five inches (twelve centimeters), extends upward from the cecum through the right lumbar into the right hypochondriac region to the under surface of the right lobe of the

liver, with which it comes into contact on the right side of the gall-bladder. Here the colon makes an abrupt turn—the **hepatic flexure**—and passes across the abdomen as the transverse colon. It lies upon the quadratus lumborum muscle, the right kidney, and the descending portion of the duodenum; to its inner side are situated the convolutions of the small intestine. When the colon is collapsed, the convolutions of the small intestine lie in front of it; but when distended, the colon is immediately behind the anterior abdominal wall. It is fixed to the posterior wall of the abdomen by extraperitoneal connective tissue and the peritoneum, which covers it in front and on the sides, and usually leaves the posterior third of this portion of the colon destitute of a peritoneal coat. In about twenty-five per cent. of cases the peritoneum surrounds it completely, forming a genuine meso-colon.

The **transverse colon** is about twenty inches (fifty centimeters) in length, and is the longest and most movable portion of the large intestine. It passes from the right hypochondriac region through the lower part of the epigastric and the upper part of the umbilical to the left hypochondriac region; there it approaches the spleen, and turns downward as the **splenic flexure**, to become the descending colon. In the epigastric and umbilical regions it lies just below the greater curvature of the stomach. It makes a long curve, the convexity of which is directed downward and forward. From its lower border is suspended the great omentum. Above it are the liver, the gall-bladder, the stomach, and the lower end of the spleen; below are the great omentum and small intestine; behind are the transverse meso-colon, the descending and the transverse portion of the duodenum; and in front are the great omentum and the anterior abdominal wall. It is entirely surrounded by peritoneum, and is attached to the posterior wall of the abdominal cavity by the transverse meso-colon. Attached to it are a number of small pouches of peritoneum containing fat—the **appendices epiploicæ**.

In some instances the transverse colon may curve so far downward that its most dependent part may reach the crest of the pubis, while the hepatic and splenic flexures continue to maintain their proper positions. The mobility of this part of the colon permits fecal accumulations to carry it downward. It is important to bear in mind the possible variations in the position of this part of the large intestine when examining obscure tumors of the abdominal cavity.

The relation which the hepatic flexure bears to the gall-bladder and the liver explains why it is found stained with bile after death; how in impaction of the gall-bladder with stones a communication the result of ulcerative inflammation may be established between the gall-bladder and the transverse colon (cholecystocolostomy), through which the former may empty itself; and, again, how a hepatic abscess may be evacuated spontaneously through the transverse colon.

The relation of the transverse colon and transverse meso-colon to the abdominal aorta explains how an aneurysm of that vessel may burst into the transverse colon, the blood first passing between the two layers of the transverse meso-colon. A fecal mass in the transverse colon may be mistaken for a tumor arising from the transverse colon, stomach, great omentum, pancreas, or lymphatic glands.

The **descending colon**, about eight inches (twenty centimeters) in length, commences at the splenic flexure of the colon in the left hypochondriac region, and descends almost vertically through the left lumbar region into the left iliac fossa, where, at the outer border of the psoas muscle, it terminates in the sigmoid flexure of the colon. At its commencement it is attached to the diaphragm, opposite the tenth and eleventh ribs, by a fold of peritoneum, the **phreno-colic ligament**, upon which rests the lower end of the spleen. Like the ascending colon, it is fixed to the posterior wall of the abdomen by extraperitoneal connective tissue and the peritoneum, which covers it in front and on the sides. A meso-colon with its two layers in contact is found more frequently on this than on the right side, being present in about thirty-five per cent. of cases. The descending colon is smaller than the ascending, more deeply situated, and more movable.

RELATIONS.—Behind the descending colon are the left crus of the diaphragm, the left kidney, and the quadratus lumborum muscle; to its inner side and in front are the convolutions of the small intestine; on its outer, or left, side is the abdominal wall.

From the relation which the ascending and the descending portion of the colon hold to the kidney and the quadratus lumborum muscles, it follows that a renal or spinal abscess may be evacuated by the way of either colon. In advanced malignant growth of the kidney the ascending or the descending colon, according to which kidney is affected, may become involved.

The colon is capable of becoming so much distended as to give rise to shortness of breath and palpitation of the heart. Distention of the large intestine renders the sides (flanks) and upper abdomen especially prominent, while distention of the small intestine renders the middle and lower abdomen prominent.

The **sigmoid flexure**, which is between seventeen and eighteen inches (about forty-five centimeters) in length, commences at the termination of the descending colon, opposite the outer border of the psoas muscle, in the left iliac fossa, and terminates opposite the middle piece of the sacrum, at the lower limit of the meso-sigmoid. It is the narrowest portion of the colon, and, as here described, includes that which is spoken of in many of the text-books on anatomy as the first portion of the rectum. Normally, owing to its long meso-sigmoid, the greater

part of the sigmoid flexure is an occupant of the pelvis. Here it lies in contact with the bladder, the uterus and its appendages, and those coils of the small intestine which occupy the pelvis. In the anatomy of the surgery of the pelvis, especially that of the female, the sigmoid flexure figures conspicuously. If distended with gas, the sigmoid flexure may rise out of the pelvis and enter the lower abdomen. It is completely surrounded by peritoneum, and is held in position by the meso-sigmoid, which includes what is spoken of in many of the text-books as the meso-rectum. The psoas muscle, external iliac vessels, spermatic vessels, and ureter lie behind the sigmoid flexure. The resistance offered to the return flow of blood through the left spermatic vein, produced by pressure of the sigmoid flexure upon that vessel in persons of constipated habit, forms one of the reasons given for the more common occurrence of varicocele upon the left than upon the right side. The sigmoid flexure forms a loop which resembles the Greek letter omega, Ω ; therefore it is called the *omega loop*.

The **recto-sigmoid curve** is the abrupt bend formed at the junction of the sigmoid flexure and rectum, caused by gravitation of the movable sigmoid flexure to the floor of the pelvis and the immobility of the rectum. It is this curve which makes it difficult, oftentimes, to pass a long tube through the rectum into the sigmoid flexure. This curve can be obliterated by letting the patient assume the "knee-chest position."

Digital examination of the sigmoid flexure.—The relative positions held by the terminal part of the sigmoid flexure and the first portion of the rectum should be borne in mind when examining for a suspected growth involving this part of the sigmoid. With the finger in the rectum, quite a small growth in the terminal part of the sigmoid flexure or in the terminal part of the meso-sigmoid can be detected. The point of the finger is not brought into immediate contact with the growth, but the tumor can be felt through the intervening wall of the first portion of the rectum. It is a well-recognized fact that malignant growths of the large bowel are more commonly met with in the rectum than elsewhere, and, next in frequency to the rectum, in the sigmoid flexure. I have been able to detect a very small growth in the terminal part of the sigmoid flexure with the finger engaged in the rectum, and also to make the diagnosis of incipient cancer in several cases in which an autopsy subsequently proved the diagnosis to have been correct. Many cases of malignant growths or infiltration of the walls of the terminal part of the sigmoid flexure and of the meso-sigmoid are often diagnosed as rectal. Further, owing to the relation existing between the terminal part of the sigmoid flexure and the left ovary, the author has known a carcinoma of this part of the bowel to be mistaken for a growth of the ovary. From the relation the sigmoid flexure bears to the uterus and its appendages, the surgeon recognizes the import-

ance of having the lower bowel emptied in examining *per vaginam* in a case of suspected mass or growth of small size.

Course of the sigmoid flexure.—In tracing the sigmoid flexure from its origin, it will be seen, first, to cross the psoas muscle and the external iliac vessels at a right angle, then to descend vertically to the floor of the pelvis, along its left wall. From this point it runs along the floor to near the right wall of the pelvis, turns upon itself, and passes to the left of the median line, to terminate in the rectum. The line of attachment of the meso-sigmoid corresponds to that of the flexure as far as its place of entrance into the pelvic cavity; from here on to its termination it corresponds to an oblique line extending from the point on the brim of the true pelvis, over which the sigmoid passes, to one opposite the third segment of the sacrum, or to a point about two and one-half inches (six centimeters) below the promontory.

Volvulus, one of the varieties of acute internal intestinal obstruction, affects the sigmoid flexure more commonly than any other portion of the intestinal tract.

Gross difference between the large and the small intestine.—The peculiarities which distinguish the large intestine are the presence of the three flat bands of longitudinal muscular fibers, its slighter degree of mobility, its greater size, and the presence of the sacculations, the appendices epiploicæ, and the scybalous masses usually found in it. The peculiarities of the small intestine are its shorter diameter, the transverse ridges produced by the valvulæ conniventes, which can be felt by rolling the small intestine between the fingers, and the absence of the characteristics of the large intestine.

Accessibility of the colon to pressure.—The colon is accessible to pressure from the cecum to the sigmoid flexure, except at the hepatic and splenic flexures, which are deeply located.

The passage of a rectal tube.—A difference of opinion occurs among surgeons concerning the possibility of introducing the long rectal tube beyond the sigmoid flexure in cases in which the position of the bowel is normal. If a very flexible rubber tube, the walls of which are thick enough to give it sufficient resisting power, be used, the tube can be made to enter the colon. The author has demonstrated this frequently in the living subject, but has not been so successful in experiments on the cadaver. The passing of such a tube in the living is very different from passing it in the cadaver. In the latter it is more difficult, if not well-nigh impossible, to pass the soft tube beyond the sigmoid flexure. The passage of the long rectal tube is facilitated in some cases by injecting water through it as it is being passed. This offers a means of determining whether the tube is traversing the sigmoid or is coiling up. If it is progressing properly and if the colon is not obstructed, the water will flow through it freely; but if it is turning on itself, the water can not be forced through it.

In the attempt to dilate a suspected stricture in the lower portion of the sigmoid the author has known the wall of the bowel to be perforated, thus causing peritonitis and death. He has not had any success with the semi-flexible tube, and considers its use for locating a stricture of the sigmoid flexure unsatisfactory, as the sigmoid, because of the length of the meso-sigmoid, is readily displaced by the point of the instrument, which engages in a fold of mucous membrane or comes into contact with the wall of the bowel, and has its further passage arrested by them. It must be borne in mind that the sigmoid can be carried over to, and even beyond, the median line, where the point of the bougie can be felt through the abdominal wall. From this it might be inferred that the bougie has passed a stricture.

The **capacity of the large intestine in the adult**, excluding that of the rectum, is four or five quarts (about four or five liters) of water; the rectum, when distended, is capable of holding from one to one and one-half quarts (about one to one and one-half liters). In order to determine, in an obscure case, between obstruction of the large and of the small intestine, the capacity of the large intestine should be ascertained.

The **meso-sigmoid** is the long fold of peritoneum connecting the sigmoid flexure to the posterior wall of the lower part of the abdominal cavity. It is continuous with the posterior parietal peritoneum and with the descending meso-colon. It surrounds the sigmoid flexure completely, and consists of two layers and an intervening process of extraperitoneal connective tissue which transmits the vessels and nerves supplying this portion of the bowel.

The Kidneys.—Although the kidneys can not be studied at this stage of the dissection, their position should be noticed, and their relations to the other organs be observed. They are found in the hypochondriac and lumbar regions, and extend slightly into the epigastric and umbilical regions. The right kidney occupies a slightly lower position than the left, because of the liver lying above it. It will be seen that the left kidney is in relation in front with the stomach, the pancreas, the spleen, and the descending colon, and that the right kidney is in relation in front with the liver, ascending colon, and duodenum. As the kidneys are situated postperitoneally and are surrounded by more or less extraperitoneal fat, these organs do not come in direct contact with the kidney or its capsule, although the superimposed weight of the liver and spleen is sufficient to make impressions on the surfaces of those viscera.

DISSECTION.—Before removing any of the viscera, certain vessels should be dissected as far as possible, because removal of the organs necessitates division of the vessels which supply them. In exposing these structures, they should be dissected in the following order: Those occupying the gastro-hepatic omentum;

those running along the greater curvature of the stomach and between the descending layers of the great omentum ; those running between the layers of the gastro-splenic omentum ; those running behind the peritoneum above the transverse meso-colon ; those running between the layers of the mesentery ; those running behind the parietal peritoneum on each side of the root of the mesentery ; and, finally, those running between the layers of the meso-sigmoid.

The structures between the layers of the gastro-hepatic omentum are exposed by removal of portions of the anterior layer of that omentum. Along its right or free border are the hepatic, the cystic, and the common bile ducts, the hepatic artery, and the portal vein. The common bile duct lies to the right ; the artery, to the left ; and the vein, behind and between the artery and duct. These structures, including lymphatic vessels and sympathetic nerve-fibers, are surrounded by a sheath of loose connective tissue, which is a process of the extra-peritoneal connective tissue, and is called **Glisson's capsule**. Along the gastric border of the lesser omentum and between its two layers are the pyloric vessels and the terminal part of the gastric vessels.

The **Common Bile Duct (Ductus Communis Choledochus)** is usually about three inches (seven centimeters) long, but varies with the length of the hepatic and cystic ducts. It has a diameter of about three-sixteenths of an inch (four or five millimeters). It is formed in the lesser omentum, by the union of the hepatic and cystic ducts, just above the upper margin of the pyloric end of the stomach or first part of the duodenum. It runs first between the layers of the lesser omentum and in front and to the right of the portal vein, along the right border of that omentum, lying to the right of the hepatic artery. In the second part of its course it passes behind either the first portion of the duodenum or the pyloric end of the stomach, lying in front of the inferior vena cava. Thence it passes along the left side of the second portion of the duodenum and behind the head of the pancreas, and finally turns slightly to the right, descending between the second portion of the duodenum and the head of the pancreas. It is then joined by the pancreatic duct, and pierces obliquely the wall of the left side of the lower part of the second portion of the duodenum, at a point about four inches (ten centimeters) from the stomach. The hepatic and the pancreatic duct may each, however, empty separately into the duodenum. The common bile duct is loosely connected with the surrounding parts by connective tissue, and with care may be separated from the portal vein and the hepatic artery ; if the greatest gentleness is not observed, either the portal vein or the vena cava will be torn. Having entered the wall of the bowel, the duct runs for about three-quarters of an inch (two centimeters) obliquely through the muscular layer. Immediately below its junction with the duct of the pancreas

and above its point of entrance into the duodenum the common bile duct is slightly dilated, making its diameter at this point about one-sixteenth inch (two millimeters) greater than it is elsewhere. It is in this dilatation, called the **ampulla of Vater**, that a gall-stone is likely to lodge, as the orifice of communication between the duct and the bowel is narrow.

Surgery of the common bile duct.—It will be seen how, owing to the relation which the common bile duct bears to the head of the pancreas, obstructive jaundice may result from occlusion due to carcinomatous enlargement of this part of the gland. By dividing the posterior parietal peritoneum from the foramen of Winslow downward along the right side of the second portion of the duodenum, and pulling the descending portion of the duodenum toward the median line, the common bile duct may easily be exposed and incised. A penetrating wound of the abdomen through the back, not piercing the peritoneal cavity, may open the portion of the common bile duct which is retro-peritoneal and result in extra-peritoneal extravasation of bile. Ulcerative perforation of the bile duct by gall-stone or rupture may take place either intraperitoneally or extraperitoneally—more often, however, intraperitoneally.

The **Hepatic Duct** is considerably larger than the cystic, though not so large as the common bile duct. It is formed by the union of two large branches in the transverse fissure of the liver, runs obliquely downward and inward between the layers of the lesser omentum for a distance of about two inches (five centimeters), and is joined by the cystic duct. It is in intimate relation with the hepatic artery, which runs along its left side, and with the portal vein, which lies behind and to the left side of it. Lying behind or crossing the duct is the cystic artery, a branch of the hepatic artery, a point important to bear in mind while making an incision into the duct.

The **Cystic Duct**, which is practically the elongated neck of the gall-bladder, varies in length from one to one and one-half inches (two to four centimeters). In a normal condition of the duct it is impossible to carry the smallest probe through it, owing to its double curved course and the peculiar arrangement of its mucous lining. The terminal portion of the cystic duct, where it joins the hepatic duct to form the common bile duct, lies in front of the portal vein, loose areolar tissue intervening. The two important points to remember in incising the cystic duct, as in the extraction of a stone, are its relation with the cystic artery and with the portal vein, the artery lying above and behind the duct, and the portal vein behind it, at the junction of the cystic and hepatic ducts.

The **Hepatic Artery**, the origin of which can not be seen until the posterior parietal peritoneum has been removed, is one of the three branches of the celiac axis. In the adult it is intermediate in size between that of the gastric and the



STRUCTURES IN GREAT OMENTUM AND LESSER OMENTUM.

splenic arteries, but in the fetus it is the largest of the three branches. It arises from the right side of the celiac axis, passes to the right, and runs forward along the upper border of the head of the pancreas, behind the ascending layer of the posterior parietal peritoneum, to the upper border of the pyloric end of the stomach or of the first portion of the duodenum. Thence it runs upward between the two layers of the gastro-hepatic omentum to reach the transverse fissure of the liver; here it divides into two branches, a right and a left branch, for the supply of the two segments of that organ which are separated by the longitudinal fissure. In its course it first lies below the foramen of Winslow and then anterior to it. The hepatic plexus of sympathetic nerves accompanies this artery.

The **branches of the hepatic artery** are the pancreatic, pyloric, gastroduodenal, cystic, and the right and left hepatic arteries.

The **Pancreatic Arteries**, which are branches of the hepatic, arise from that artery as it runs along the upper border of the head of the pancreas, but can not be seen until the trunk of the hepatic artery is exposed.

The **Pyloric Artery** arises from the hepatic artery at a point a short distance above the place where that vessel enters the lesser omentum. It descends to the upper border of the pylorus, turns to the left, and runs along the lesser curvature of the stomach, and anastomoses with the terminal part of the gastric artery.

The **Pyloric Vein** arises from small veins along the lesser curvature of the stomach, runs upward and toward the right, and empties into the lower part of the portal vein.

The **Gastro-duodenal Artery** arises from the hepatic artery between the layers of the gastro-hepatic omentum, and descends behind the first portion of the duodenum to its lower border, where it divides into two terminal branches, the right gastro-epiploic and the superior pancreatico-duodenal arteries. The greater portion of the gastro-duodenal artery, as well as the commencement of the superior pancreatico-duodenal branch, can not be seen satisfactorily until the first and second portions of the duodenum and the head of the pancreas have been displaced. There is no vein which corresponds to this artery.

In operations upon the stomach the walls, and not the greater curvature, are selected for the point of incision on account of the distribution of these vessels.

The **Superior Pancreatico-duodenal Artery** takes a curved course around the margin of the head of the pancreas, between it and the duodenum, to both of which it supplies branches. It terminates by anastomosing with the inferior pancreatico-duodenal, which is a branch of the superior mesenteric artery.

The **Pancreatico-duodenal Vein**, which drains the area supplied by the two arteries of that name, empties into the superior mesenteric vein.

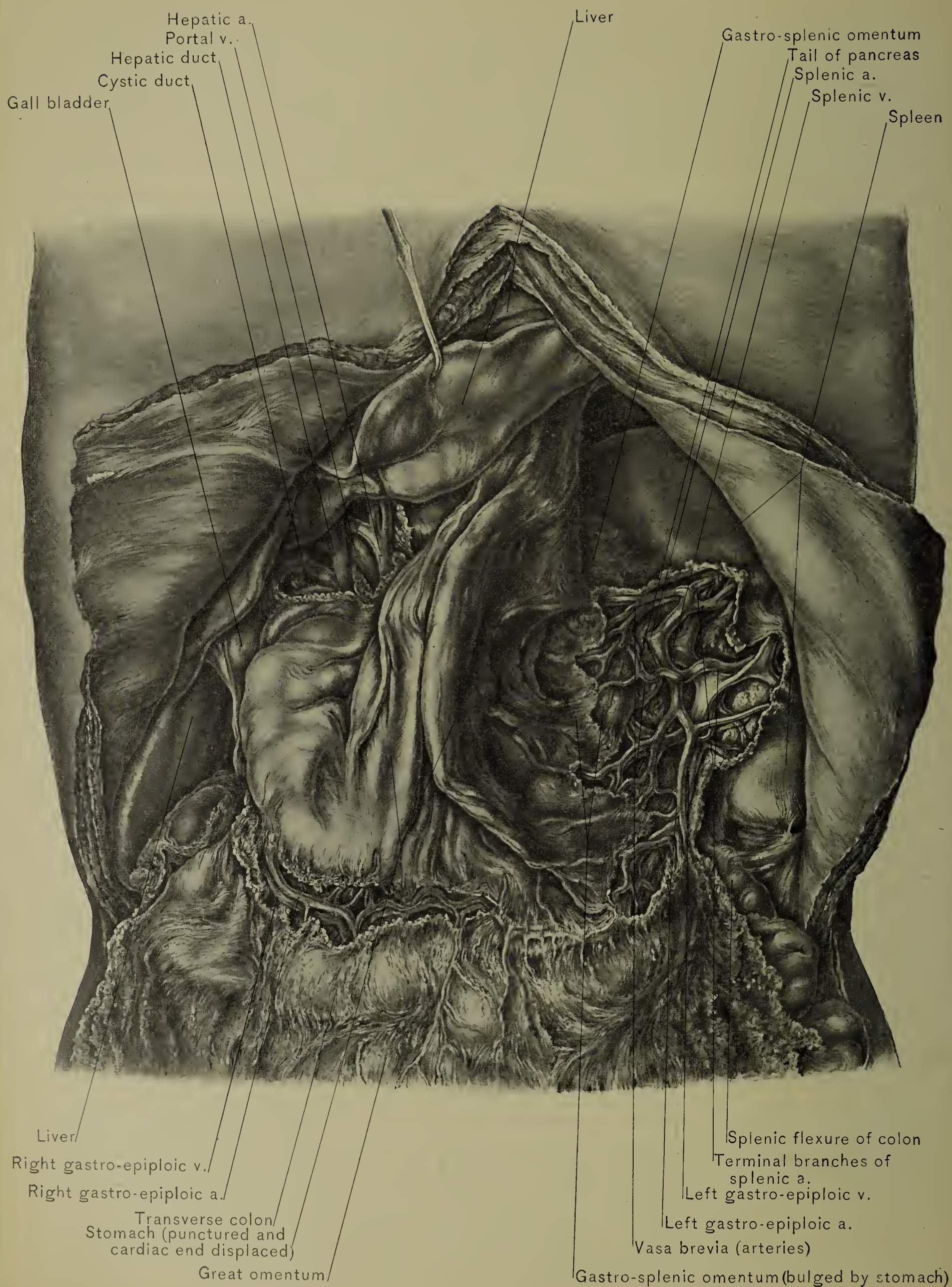
The **Cystic Artery** usually arises from the division of the hepatic artery going to the right lobe of the liver, and runs to the gall-bladder, behind and above the cystic duct, and behind or in front of the hepatic duct. It divides into two branches, one of which ramifies over the free surface beneath the peritoneum, the other over the attached surface, which is in contact with the liver. This artery is sometimes quite large, and is of great importance in the surgery of the hepatic and cystic ducts.

The **Cystic Vein** accompanies the cystic artery, and usually empties into the right branch of the portal vein.

The **Gastric or Coronary Artery** is the smallest of the three branches of the celiac axis. It runs toward the left and slightly upward, behind the lesser peritoneal cavity and the posterior parietal peritoneum, until it approaches the lesser curvature of the stomach, just below the termination of the esophagus. Here it turns forward between the two layers of the gastro-phrenic ligament, and gives off two or three esophageal branches and a small hepatic branch, which enters the left lobe of the liver. In the remainder of its course it runs downward and toward the right, between the two layers of the lesser omentum and along the lesser curvature of the stomach. It gives off a hepatic branch to the left lobe of the liver, esophageal branches to the lower portion of the esophagus, and gastric branches to the anterior and posterior walls of the stomach, and finally anastomoses with the pyloric artery.

The **Gastric or Coronary Vein** follows the course of the gastric artery, except that it runs in the opposite direction. It empties into the portal vein.

The **Portal Vein** is formed by the union of the superior mesenteric and splenic veins, behind the head of the pancreas and in front of the inferior vena cava. It is from three to four inches (seven to ten centimeters) in length, passes upward and to the right, behind the first portion of the duodenum, and then between the layers of the lesser omentum. It is surrounded by branches of the hepatic plexus of the sympathetic nerve, lymphatic vessels and glands, and the capsule of Glisson. It lies behind the common bile and hepatic ducts and the hepatic artery, the ducts being to the right, the artery to the left, and the vein behind and between the artery and the ducts. Like the hepatic artery, it divides at the transverse fissure of the liver into a right and a left branch, which enter the respective lobes at that fissure. The branch passing to the right lobe of the liver is almost a direct continuation of the portal vein, whereas the branch passing to the left lobe diverges at a right angle from the main stem. Owing to the more direct course of the right branch, infectious material carried from the stomach or intestine to the liver by the portal vein is more likely to enter the right branch and lead to involvement of the right lobe. A slight dilatation immediately below the point



VASA BREVIA,—STRUCTURES IN GASTRO-SPLENIC OMENTUM.

where it divides into its two branches is called the sinus of the portal vein. It receives the gastric, the pyloric, and the cystic veins. The veins of the portal system are the portal, gastric, splenic, and superior and inferior mesenteric veins, which return the blood from the entire portion of the alimentary canal that lies between the lower end of the esophagus and the termination of the rectum. These veins contain no valves, their absence being held to be an important predisposing cause in the formation of hemorrhoids.

The radicles of the portal vein anastomose with the systemic veins in numerous places; among these anastomoses are the following: Radicles of the superior hemorrhoidal vein anastomose with branches of the middle and inferior hemorrhoidal veins, these last being tributaries of the internal iliac vein; the gastric tributaries of the portal vein anastomose with the lower esophageal veins, which empty into the azygos vein. In the suspensory ligament of the liver are veins which connect the portal system with the veins of the diaphragm; along the round ligament of the liver there are one or two veins which effect an anastomosis between the portal system and the veins of the abdominal wall. In cases of obstruction to the portal vein, as seen in cirrhosis of the liver, these anastomosing channels may become enlarged, to assist in establishing collateral circulation. It is appropriate, in this connection, to remind the reader of the enlargement of the spleen met with in cirrhosis of the liver, due to the constant venous congestion of that organ from the interference with the portal circulation and consequent damming back of the blood in the splenic vein.

The Vessels between the Descending Layers of the Gastro-colic Omentum.—These vessels, the right and the left gastro-epiploic, with their descending branches, are exposed by removal of the anterior of the two layers of the great omentum along the greater curvature of the stomach.

The **right gastro-epiploic artery** arises from the gastro-duodenal artery, and runs along the greater curvature of the stomach, between the descending layers of the great omentum. It sends branches to the stomach and great omentum, and anastomoses with the left gastro-epiploic artery.

The **left gastro-epiploic artery** arises from the splenic artery or one of its terminal branches, behind the cardiac end of the stomach, descends between the two layers of the gastro-splenic omentum, and finally passes downward and toward the right, along the greater curvature of the stomach, between the two anterior layers of the great omentum, anastomosing with the right gastro-epiploic artery.

The **gastro-epiploic veins** accompany the gastro-epiploic arteries. The *right gastro-epiploic vein* empties into the superior mesenteric vein, near its junction with the splenic vein. The *left gastro-epiploic vein* empties into the commencement of the splenic vein or into one of its branches emerging from the spleen.

The **Structures in the Gastro-splenic Omentum** are the vasa brevia, the origin of the left gastro-epiploic artery, the venæ comites of these arteries, lymphatic vessels, and sympathetic nerves.

The **vasa brevia** are small arteries which arise from the terminal part of the splenic artery or its terminal branches, and pass between the layers of the gastro-splenic omentum, to reach the cardiac end of the stomach.

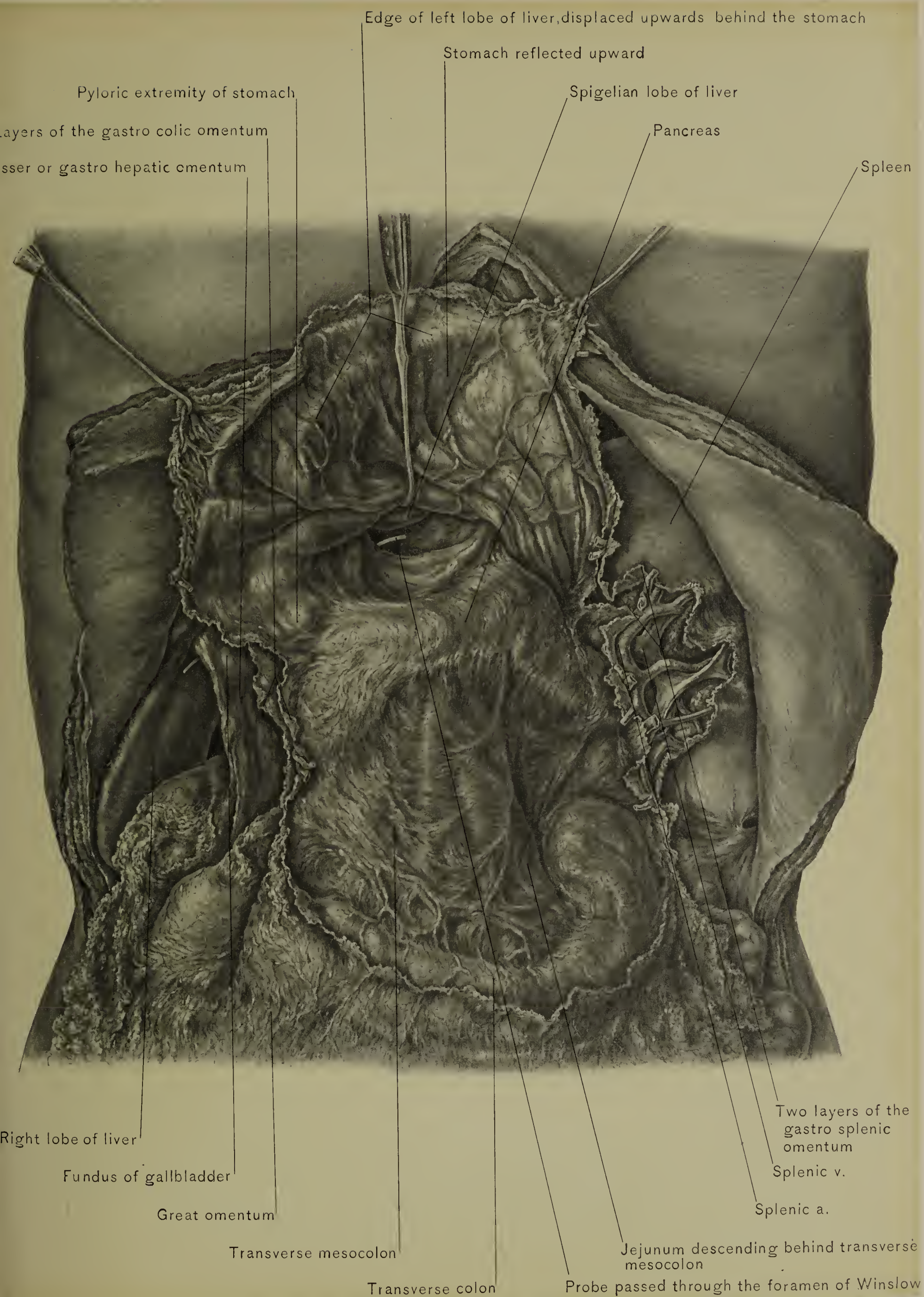
DISSECTION.—At this stage of the dissection the great omentum and gastro-splenic omentum should be divided along the greater curvature of the stomach, and the stomach and lesser omentum should be displaced forward and upward, to obtain a better conception of the location and extent of the lesser peritoneal cavity.

The **Structures behind the Ascending Layer of the Posterior Parietal Peritoneum and behind the Interval formed by Removal of the Lesser Omentum** should next be exposed, by removal of the ascending portion of the posterior parietal peritoneum. These structures are part of the pancreas, the celiac axis, the splenic artery, the origins of the hepatic, gastric, and phrenic arteries, the solar plexus of nerves, the splenic vein, the terminal parts of the superior and of the inferior mesenteric veins, and part of the aorta and inferior vena cava. These structures should be exposed by removing the ascending portion of the posterior parietal peritoneum, and their relations should be observed before they are much disturbed. The description of these structures will be given further on.

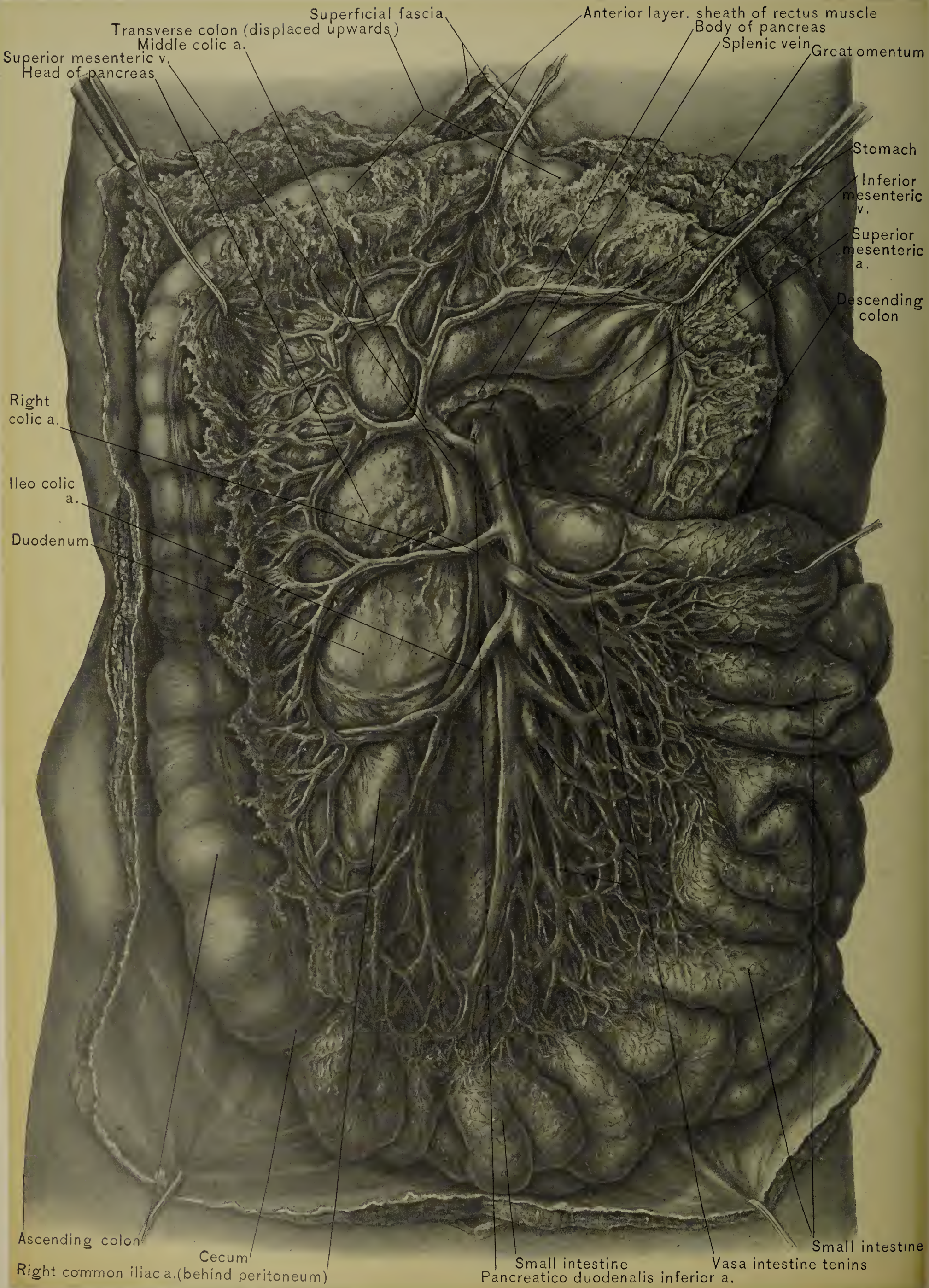
The **Structures between the Layers of the Mesentery** are the superior mesenteric artery and vein, the vasa intestini tenuis, lymphatic glands and vessels, and sympathetic nerve-fibers.

DISSECTION.—In order to expose the vessels of the mesentery the great omentum and transverse colon should be displaced upward, and the jejunum and ileum spread out on the left side of the body, so as to allow a full view of the anterior or right surface of the mesentery. The superior mesenteric artery and vein, their branches, and the lymphatic glands may be seen through the anterior or right layer of the mesentery, and the posterior parietal peritoneum, between the root of the mesentery and the ascending colon. The peritoneum should now be removed from the right side of the mesentery, from the posterior abdominal wall as far as the ascending colon, and from the under surface of the transverse mesocolon. This part of the dissection can be performed with the fingers and the handle of the scalpel. The vessels should next be traced out of the extra-peritoneal connective tissue which envelops them. In doing this the nerves of the superior mesenteric plexus should be observed.

The **Superior Mesenteric Artery** is seen emerging between the lower border of the pancreas and the upper border of the third portion of the duodenum, and arises from the front of the aorta but a short distance below the celiac axis. Its



STRUCTURES BEHIND THE POSTERIOR PARIETAL LAYER OF PERITONEUM,—THE LESSER OMENTUM.



SUPERIOR MESENTERIC VESSELS.

origin lies behind the pancreas and the splenic vein, and will be exposed in the dissection of the duodenum and the pancreas. Having passed between the pancreas and the duodenum, it crosses over the transverse portion of the duodenum, runs beneath the descending layer of the peritoneum for a short distance, and traverses the extraperitoneal connective tissue of the mesentery near the root of the mesentery. In its course through the mesentery it describes a curve, the convexity of which is directed to the left. It ends in the right iliac fossa, where it anastomoses with its ileo-colic branch.

The superior mesenteric artery supplies the third and fourth portions of the duodenum, jejunum, ileum, vermiform appendix, cecum, ascending colon, and transverse colon. It is surrounded by the superior mesenteric plexus of sympathetic nerves.

The **Superior Mesenteric Vein** accompanies the superior mesenteric artery, and its terminal portion, like the commencement of the artery, crosses the transverse portion of the duodenum and passes behind the pancreas. The vein commences in tributaries which correspond to the branches of the artery. It lies to the right of the artery, and at its termination joins the splenic vein, to form the portal vein.

The **Branches of the Superior Mesenteric Artery** are the inferior pancreatico-duodenal, the middle colic, the right colic, the ileo-colic, and the vasa intestini tenuis arteries.

The **inferior pancreatico-duodenal artery** runs toward the right, along the upper border of the transverse portion of the duodenum, in the groove between that viscus and the pancreas, to anastomose with the superior pancreatico-duodenal artery.

The colic branches.—The ileo-colic and the right and middle colic arteries arise from the concave side of the superior mesenteric artery and supply the large intestine. Of the colic branches, the ileo-colic occupies a greater portion of the mesentery than the other two.

The **middle colic artery**, which often arises by a common trunk with the **right colic artery**, passes between the layers of the transverse mesocolon, and divides into two branches—a left and a right branch. The left branch anastomoses with the ascending branch of the left colic artery, and the right, with the ascending branch of the right colic artery.

The **right colic artery** passes behind the posterior parietal peritoneum, which forms the inner layer of the ascending meso-colon, to near the ascending colon, where it divides into a descending and an ascending branch. The descending branch anastomoses with the colic branch of the ileo-colic, and the ascending branch with the right branch of the middle colic artery.

The **ileo-colic artery** descends to the right iliac fossa, behind the peritoneum, to a point opposite the cecum, where it divides into two branches—an ileac (descending) and a colic (ascending) branch. The *ileac branch* runs chiefly in the mesentery, and anastomoses with the termination of the superior mesenteric artery. The *colic branch* runs behind the peritoneum, which forms the inner layer of the ascending meso-colon, and anastomoses with the descending branch of the right colic artery. By the anastomosis of the ileac and colic branches with the respective vessels upon each side two arches are formed. These arches in turn give off branches which form a second arch, from which branches are given off to the terminal part of the ileum, cecum, vermiform appendix, and ascending colon. The branches supplying the terminal part of the ileum, the cecum, and the vermiform appendix are derived from the secondary loop formed by the anastomoses of the ileac branch of the ileo-colic artery with the terminal part of the superior mesenteric artery.

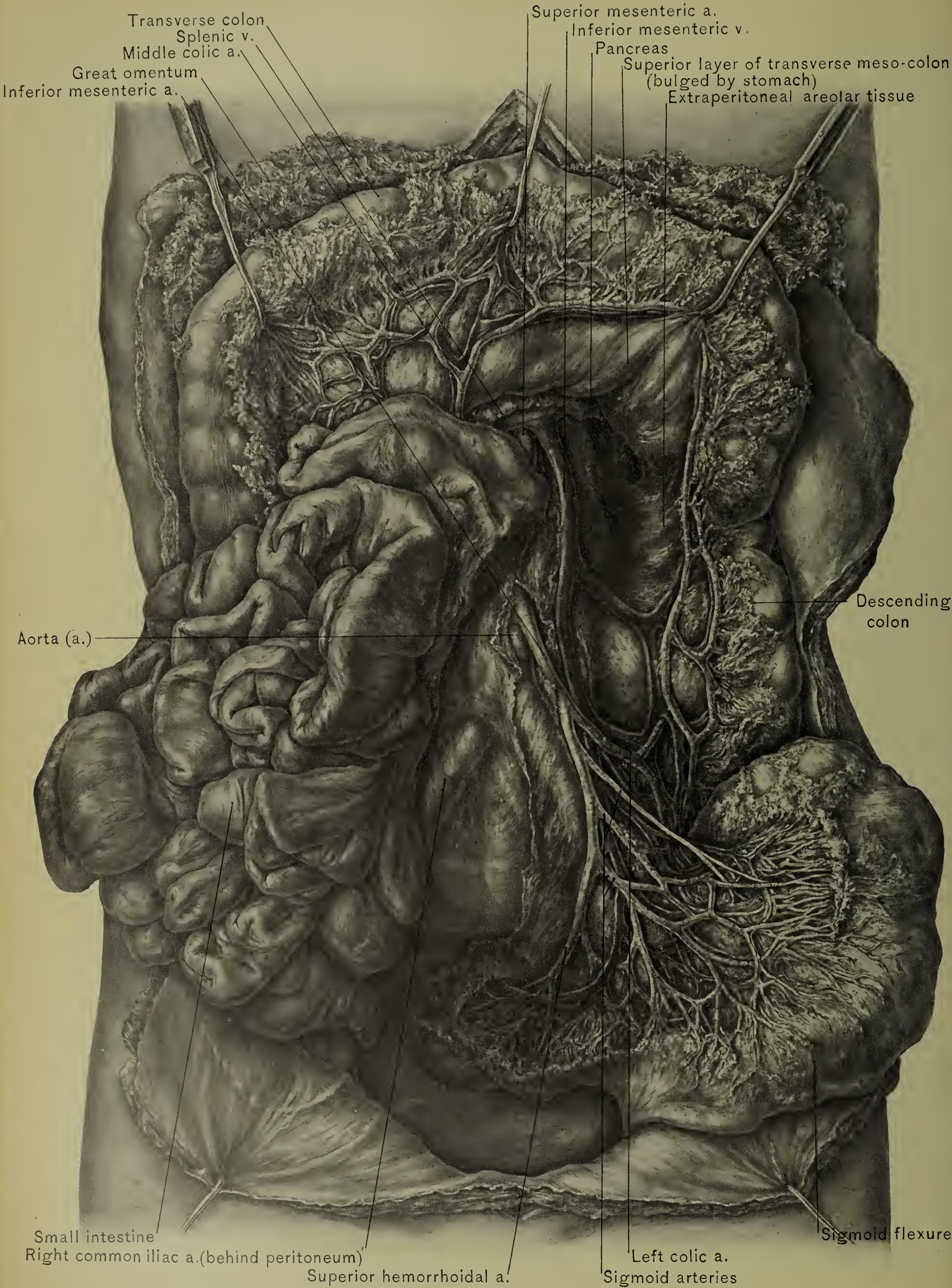
The **appendicular artery** is the branch of the ileo-colic artery which supplies the vermiform appendix and reaches that organ by way of the meso-appendix.

The **appendicular veins**, as well as the lymphatic vessels of the appendix, are of special importance in connection with the study of the pathology of appendicitis, demonstrating the course which infection may take through channels other than the peritoneum. Septic material taken up by the appendicular vein may reach the portal vein and produce inflammation and thrombosis of that vessel.

The **vasa intestini tenuis** are the only branches of the superior mesenteric artery confined entirely to the mesentery. They arise from the convex side of the artery, vary in number from twelve to sixteen, and supply the jejunum, ileum, mesentery, and the mesenteric glands. Each of the vasa intestini tenuis divides into two branches, which anastomose with the corresponding adjacent branch of the nearest artery; each of these branches again divides and forms another anastomosis, thus making from three to five tiers of arterial arches. From the last set of arches the branches which supply the bowel are derived. These branches pass transversely around the intestine. By the circular arrangement of the vessels in the coats of the small intestine the intestine may, in most instances, be distinguished from the sac of a hernia.

DISSECTION.—Before replacing the great omentum and the transverse colon, the small intestine and the mesentery should be drawn over to the right side of the abdomen. This will expose the posterior parietal peritoneum, which extends from the root of the mesentery to the descending colon and the meso-sigmoid. To the left of the aorta the inferior mesenteric artery may be seen through the peritoneum, which should now be removed, and the vessels be traced through the extraperitoneal connective tissue which supports them.





INFERIOR MESENTERIC VESSELS.

The **Inferior Mesenteric Artery**, which is smaller than the superior mesenteric artery, arises from the front of the aorta, from one to two inches (three to five centimeters) above its bifurcation, and about the same distance below the superior mesenteric artery. It passes obliquely downward, describing a slight curve, the convexity of which is directed to the left, and, after crossing the left psoas muscle and common iliac artery, it passes into the pelvis between the layers of the meso-sigmoid, and terminates as the superior hemorrhoidal artery. It supplies the descending colon, the sigmoid flexure, and the upper part of the rectum. The artery is accompanied by the inferior mesenteric vein, which lies to the left of the artery, and is surrounded by the inferior mesenteric plexus of sympathetic nerves.

The **Inferior Mesenteric Vein** begins at the rectum, in the superior and middle hemorrhoidal veins, and passes out of the pelvis between the layers of the meso-sigmoid. It soon leaves the inferior mesenteric artery, and runs upward on the left side of the aorta, over the psoas muscle, and behind the peritoneum, in the extraperitoneal connective tissue. It finally passes under the transverse portion of the duodenum and the pancreas, to empty into the splenic vein. It is therefore considerably longer than the corresponding artery.

The **Branches of the Inferior Mesenteric Artery** are the left colic, the sigmoid, and the superior hemorrhoidal arteries.

The **left colic artery** is the first branch of the inferior mesenteric artery, and passes transversely outward behind the peritoneum and in front of the lower part of the left kidney to a point near the descending colon, where it divides into an ascending and a descending branch. The *ascending branch* passes upward along the inner side of the descending colon, enters the transverse meso-colon, and anastomoses with the left branch of the middle colic artery. The *descending branch* enters the meso-sigmoid, and anastomoses with the ascending branch of the sigmoid artery.

The **sigmoid arteries**, one to three in number, pass obliquely downward and to the left over the psoas magnus muscle, enter the meso-sigmoid, and divide into ascending and descending branches which form arterial arches with the adjacent arteries. The upper and lower of these branches anastomose with the descending branch of the left colic and with the superior hemorrhoidal artery respectively.

The **superior hemorrhoidal artery**, the continuation of the inferior mesenteric artery, passes downward into the pelvis between the layers of the meso-sigmoid, and, reaching the terminal part of the sigmoid flexure, divides into two branches which pass to the sides of this part of the bowel and the upper part of the rectum. It anastomoses with the sigmoid and middle and inferior hemorrhoidal arteries.

DISSECTION.—The entire portion of the intestine between the duodenum and

the sigmoid flexure should be removed. To do this the upper end of the jejunum and the lower end of the descending colon should be severed between ligatures, and the vessels, mesentery, and meso-colon divided at their attachment to the intestine. Before proceeding further, the part of the intestine which has been removed should be examined.

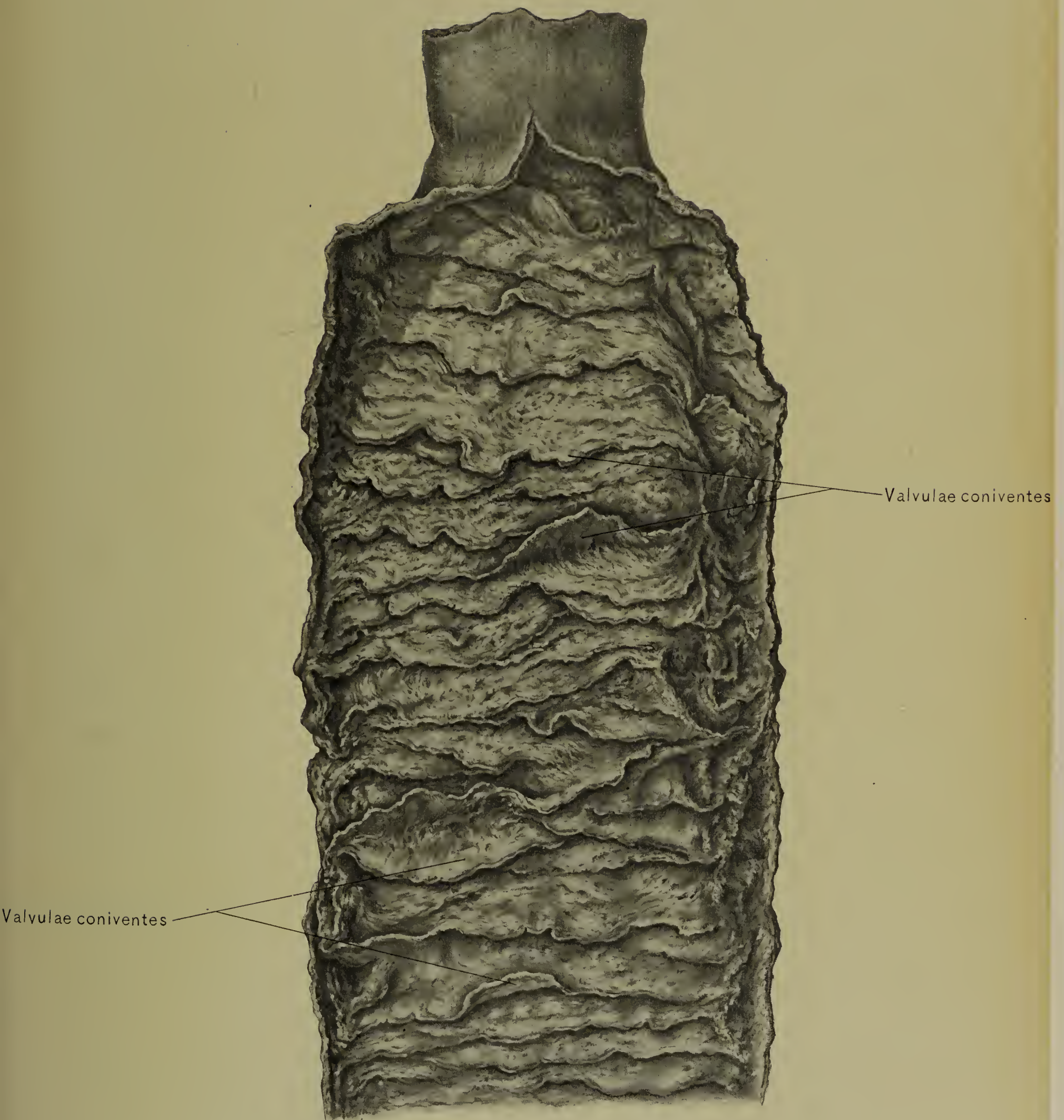
The **Wall of the Small Intestine** is made up of four coats—the serous, muscular, submucous, and mucous.

The **serous coat** is formed by the visceral portion of the peritoneum, and has been fully described under the dissection of that membrane. It will be remembered that certain parts of the duodenum are devoid of this covering, and that the remainder of the small intestine is entirely surrounded by it, with the exception of the line of attachment of the mesentery, where there is a slight interval between the two layers of peritoneum as they diverge to pass around the gut. After intestinal anastomosis union does not occur so quickly at this line as elsewhere, owing to the absence of peritoneum in this location; consequently leakage from the bowel into the peritoneal cavity after this operation is most likely to occur at the attachment of the mesentery.

The **muscular coat** is composed of two layers, an external, or longitudinal, and an internal, or circular, layer. Both of these layers are about uniformly disposed around the bowel. The circular layer is somewhat thicker than the longitudinal layer. For this reason longitudinal wounds of the gut gape more widely than transverse ones.

The **submucous coat** connects the muscular with the mucous coat. It is composed of loose areolar tissue.

The **mucous coat** of the small intestine is quite thick and highly vascular at the upper part of the bowel, becoming thinner below. It may be divided into three layers, the first of which, however, is often described with the submucous layer. This first layer consists of unstriped muscular fibers, known as the *muscularis mucosæ*. It lies between the submucous coat and the second layer of the mucous coat. The second layer consists of retiform connective tissue, in which the nerves and vessels ramify, and in which are found numerous lymph corpuscles. The third layer is made up of a coat of basement membrane which supports a layer of columnar epithelial cells. In order to study the mucous membrane thoroughly it is necessary to incise the gut longitudinally, making the incision along the attachment of the mesentery. When this has been done, it will be seen that the mucous membrane forms transverse ridges or folds—the **valvulæ conniventes**. They differ from the folds of mucous membrane found in the stomach in being transverse instead of longitudinal, and in being permanent, while those of the stomach disappear when the organ is distended. These folds



INTERNAL SURFACE OF SMALL INTESTINE SHOWING VALVULÆ CONNIVENTES.



INTERNAL SURFACE OF ILEUM SHOWING PEYER'S PATCHES.

in the intestine vary in size, some being much larger than others. They are absent in the first part of the duodenum, most numerous in the upper half of the jejunum, and gradually disappear in the ileum. Scattered over the entire surface of the small intestine are minute projections, or *villi*, which give the surface a velvety appearance. They are most numerous in the duodenum and jejunum, becoming fewer and smaller in the ileum. A villus is a projection of the mucous membrane. It is composed of one or two lacteals, a plexus of blood-vessels, nerve-fibers, unstriated muscular fibers, and connective tissue, all surrounded by the basement membrane and epithelium. For a minute description of them the student is referred to works upon histology.

The **glands** found in the small intestine are : Brunner's glands, the crypts of Lieberkühn, the solitary glands, and Peyer's patches.

Brunner's glands (duodenal glands) are small compound racemose glands found in the duodenum and the commencement of the jejunum. They are embedded in the submucous layer. Their ducts open on the mucous membrane and discharge a serous secretion. Abscess of these glands may produce a perforating ulcer of the duodenum.

The **crypts of Lieberkühn** are tubular glands scattered throughout the mucous membrane of the small and the large intestine. They secrete mucus.

The **solitary glands** consists of small, whitish bodies scattered through the mucous membrane of both the small and the large intestine, and are more numerous in the small bowel. They are lymph follicles.

Peyer's patches (agminated glands) are collections of lymphoid tissue measuring from one-half to three inches (one to seven centimeters) in length, and from one-half to one inch (one to two and one-half centimeters) in width. They are situated in the part of the wall of the bowel furthest from the attachment of the mesentery in the mucous membrane, with their long diameter directed longitudinally. They are largest and most numerous in the lower part of the ileum, and are seldom found as high as the jejunum. Neither Peyer's patches nor the solitary glands are secretory in function. They are best developed in young persons, and atrophy as age advances, so that their location in old persons is marked merely by a discolored patch. These glands show the most conspicuous lesion in typhoid fever, in which affection they undergo congestion, necrosis, ulceration, and repair by formation of scar tissue. The ulcer formed may perforate the bowel and allow escape of feces, thus producing peritonitis. Separation of the necrotic tissues may give rise to serious hemorrhage.

BLOOD SUPPLY.—The blood supply of the small intestine is derived from the superior mesenteric artery and from a branch of the hepatic—the superior pancreatico-duodenal. As seen in the dissection of the mesentery, the superior

mesenteric artery runs between the layers of that structure and gives off the vasa intestini tenuis, which divide, subdivide, and form numerous arches, which finally furnish branches that encircle the gut. One branch—the inferior pancreaticoduodenal—anastomoses with the superior pancreaticoduodenal artery and forms a plexus in the concavity of the curve of the duodenum. This part of the intestine is supplied with blood by this arterial loop. The veins of the small intestine begin in small branches which empty into the superior mesenteric vein.

NERVE SUPPLY.—The nerve supply of the small intestine is derived from the superior mesenteric plexus, the latter being continuous with the lower portion of the solar plexus. The branches of this plexus follow the branches of the superior mesenteric artery. These sympathetic nerves form two plexuses in the wall of the bowel. One of these is situated between the circular and longitudinal muscular layers, and is known as Auerbach's plexus; the other is in the submucous coat, and is known as Meissner's plexus. These plexuses contain ganglia and control the muscular tissue of the bowel. In acute peritonitis, typhoid fever, and in various other conditions, these plexuses become more or less paralyzed. This allows muscular relaxation and gaseous distention of the intestines (tympanites).

There are many differences between the jejunum and the ileum, although the dividing-line between these two portions of the bowel is not distinct or well defined. Thus:

1. The lumen of the jejunum is one-fourth of an inch (six millimeters) wider.
2. The wall of the jejunum is thicker.
3. The vascularity of the jejunum is greater.
4. The villi of the jejunum are more numerous.
5. Peyer's patches exist in the ileum, having their greatest development at its lower end, from which they gradually grow smaller and less frequent as the jejunum is reached, in which portion of the bowel they are rounded and infrequent.
6. At postmortem the jejunum is generally found empty; the ileum more frequently contains feces.
7. Occasionally the remains of the vitello-intestinal duct (Meckel's diverticulum) are found near the lower end of the ileum.
8. The jejunum lies in the umbilical and left iliac regions and in the pelvis, while the ileum is more generally found in the right iliac and hypogastric regions and in the pelvis.
9. The jejunum forms about two-fifths, and the ileum about three-fifths, of the length of the small gut.
10. The jejunum contains more valvulæ conniventes and is more important

physiologically. On account of the latter distinction, other things being equal, injuries or herniæ of the jejunum are more serious than are those of the ileum. This difference in physiologic importance explains the greater fatality of umbilical hernia, which usually involves the jejunum; while in inguinal and femoral herniæ, the ileum is more commonly involved.

The **intestinal lymphatics** and their associated glands lie between the two layers of the mesentery, hence the designation, mesenteric glands. They vary in size from that of a pea to that of a small almond, and in number from a hundred to a hundred and fifty. They occupy the interspaces between the inosculations of the branches of the superior mesenteric artery. They are largest and most abundant at both ends of the small intestine—*i. e.*, near the duodenum and near the ileo-colic junction. In the colon they are fewer, the transverse portion having the smallest number.

The **lymphatic vessels of the small intestine** begin in closed extremities in the villi of the intestinal mucous membrane, where they absorb the fatty products of digestion and carry them, emulsified and milk-like, to the mesenteric glands. Although usually as imperceptible as lymphatics elsewhere, they are readily distinguished, after a meal, as milk-white threads in the mesentery, and hence the name *lacteals*. These vessels, after passing through several successive series of mesenteric glands, each time becoming less numerous but larger, enter the *receptaculum chyli*, which is situated in front of the body of the second lumbar vertebra.

Injuries of the small intestine.—Of all the viscera, the small intestine is most exposed to injury. At the same time it must be borne in mind that, owing to its mobility and the ease with which its coils glide over one another, it is enabled to escape the effects of pressure, thus rendering it better adapted to meet such injuries as contusions of the abdominal wall. In excessive tympanites of the bowels, puncturing it in many places with a fine aspirating trocar to allow the escape of gas is said not to occasion any evil results. This I am disposed to question. At any rate I feel that little good can be accomplished by this procedure, while much harm can be done. I certainly would hesitate to recommend it in the light of recent advances in abdominal surgery. The argument in favor of inflicting penetrating wounds of the small intestine, such as those occasioned by the aspirating trocar, is that the openings in the bowel are immediately closed by the contraction of the muscular coat or by the protrusion of the mucous membrane through them. This is not likely to be so where the muscular coat is paretic, which is so frequently the case where the tympany is so marked as to call for relief. Even if there is no discharge of fecal matter, there must, at least, be an escape of infectious gas and bacteria more than sufficient in quantity and number to cause septic peritonitis.

Gross found that a longitudinal incision in the small intestine two and a half lines (5.2 millimeters) in length was immediately reduced to a wound one and three-fourths lines (3.6 millimeters) in length by muscular contraction, and that in addition to this contraction the eversion of the mucous membrane entirely sealed the opening. A longitudinal wound of the small intestine will gape more than a transverse wound, owing to the circular fibers possessing more power than the longitudinal fibers. The muscular coat of the jejunum is better developed than that of the ileum; therefore wounds of the former gape more than do those of the latter. The longitudinal muscular fibers being thicker along the free border of the gut than at the attachment of the mesentery, transverse wounds gape most when inflicted at the free border.

The **Wall of the Large Intestine**, like that of the small intestine, is composed of four coats—the serous, muscular, submucous, and mucous.

The **serous coat** is derived from the peritoneum, and has been fully described under the dissection of that membrane. It differs from the serous coat of the small intestine in forming small projections or pouches filled with fat—*appendices epiploicæ*.

The **muscular coat** is composed of two layers—the longitudinal and the circular, the former being external. The longitudinal fibers are arranged in three bands, these bands being so marked as to be plainly visible through the serous coat. But a few longitudinal fibers are found between the bands, except in the appendix and the rectum, where longitudinal fibers are found uniformly distributed around the bowel. These longitudinal bands are shorter than the other structures of the large intestine, and, therefore, pucker it into sacculi. The circular layers form a very thin layer over the cecum and colon, where they are found most abundantly between the sacculi. In the lower part of the rectum they are most abundant, and in that position form a thick layer which constitutes the **internal anal sphincter**.

The **submucous coat** consists of areolar tissue which connects the muscular and mucous coats.

The **mucous membrane** is smooth and destitute of villi and valvulæ conniventes. It may be divided into three layers, as in the small intestine. The external layer consists of muscular fibers, the muscularis mucosæ; the second layer is made up of retiform connective tissue in which the vessels ramify; the third layer is composed of a basement membrane and columnar epithelium.

The **glands of the large intestine** are the crypts of Lieberkühn and the solitary glands.

The *crypts of Lieberkühn* are similar to those in the small bowel, but are more numerous.

The *solitary glands* or lymph follicles are similar to those of the small intestine, but are not so numerous. They are most abundant in the vermiform appendix and cecum.

The **structure of the appendix** closely resembles that of the large intestine, but is somewhat different. The **mucous membrane lining the appendix** is composed of a delicate retiform connective tissue containing numerous lymphoid cells within its meshes, and has a plentiful supply of solitary glands and glands of Lieberkühn. The latter glands vary much in size and number, and are often entirely absent. The retiform connective tissue is lined with a basement membrane on which are found columnar epithelial cells covered with clusters of various micro-organisms. Between the mucous and submucous coats a thin layer of circular muscular fibers may be distinguished, forming the *muscularis mucosæ*.

The **submucosa** is formed of areolar tissue, is much denser than the mucous coat, and contains a large quantity of lymphoid tissue. Numerous small arteries and veins supplying the mucous membrane are present in the submucosa, and it generally contains a small quantity of fat.

From within the cecum may be seen a prominence of the mucous membrane partially or completely surrounding the orifice of the appendix, due to an increase of the lymphoid tissue. This, under certain circumstances, may act as a valve, and thus favor occlusion of the orifice. Hypertrophy of the lymphoid tissue in the wall of the appendix frequently occurs in typhoid fever, and may lead to obstruction of the lumen of the organ and stagnation of its fecal contents. Consequently typhoid fever is sometimes a predisposing cause of appendicitis.

The **muscular coat** consists of two layers. The inner layer is a thick layer of circular fibers, at times constituting fully one-third the entire thickness of the appendicial wall. The outer layer is composed of longitudinal fibers. It is not so thick as the inner layer, nor are the muscular fibers so regular, for at times they are bunched at certain points in a manner similar to that occurring in the outer layer of the muscular coat of the cecum.

Probably one of the strongest evidences of the existence of the longitudinal muscular fibers is demonstrated after the removal of the vermiform appendix, when the organ rapidly shrinks, by the contraction of the fibers, sometimes to one-third of its original length. The circular fibers possess the same power, for when the appendix has been incised to expose its canal, there will immediately be noticed a contraction of the circular fibers, thus bringing the mucous lining into view.

The **peritoneal coat**, or serous covering, of the appendix is similar to the peritoneum in general. Its extent in regard to the appendix has already been described.

The vascular supply of the viscera in the right iliac fossa is derived from

loops formed by the anastomoses of the right colic and the ileo-colic arteries, branches of the superior mesenteric artery. From these loops secondary loops are given off; and from these are derived the arteries that supply the appendix and the ileo-cecal region. The branch to the appendix—the appendicular artery—passes along the free edge of the meso-appendix, if that structure is present. In the absence of the meso-appendix the artery usually passes beneath the peritoneal coat of the appendix. In exceptional cases the artery may pass directly to the tip of the appendix, in which case it will not give off branches until it has entered the submucosa. In the female, at times, there is an additional supply of blood brought to the appendix through the folds of the appendiculo-ovarian ligament.

The **lymphatics of the appendix** pass to a chain of glands in the angle formed by the junction of the appendix with the cecum. The lymphatics may empty into those of the ovary by passing along the appendiculo-ovarian ligament, in this way forming a lymphatic communication between the appendix and the right ovary.

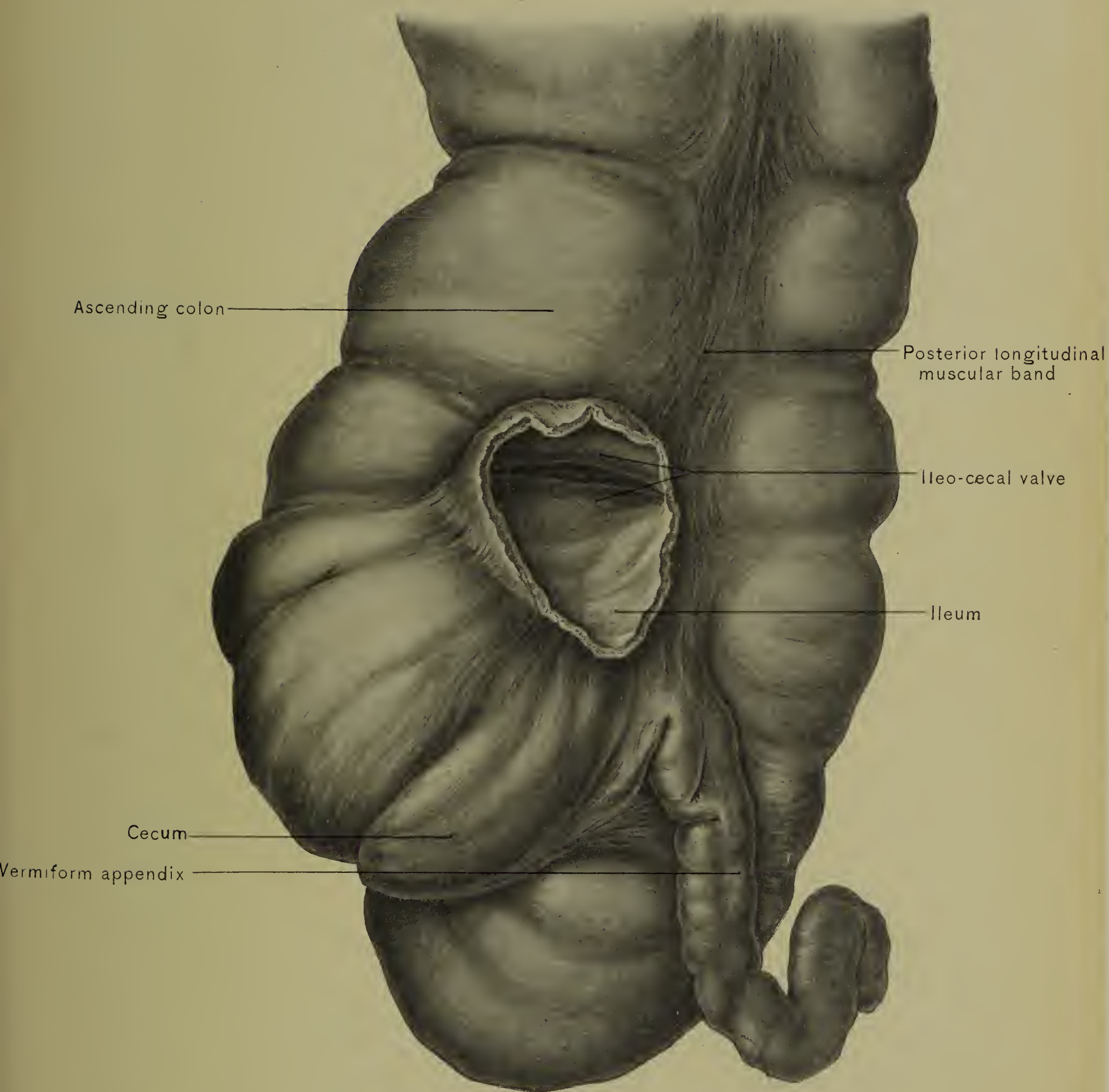
The **nerves of the appendix** are derived from the superior mesenteric plexus of the sympathetic, the branches of this plexus, which accompany the ileo-colic artery, sending filaments to the appendix. As this plexus gives off numerous twigs to the small intestine, it becomes clear how pain due to disease of the appendix may be referred to the whole of the abdomen or to any region of it.

BLOOD SUPPLY.—The blood supply of the large intestine is derived from branches of the superior and inferior mesenteric, internal iliac, and internal pudic arteries. The branches which supply the rectum are the superior hemorrhoidal branch of the inferior mesenteric artery, the middle hemorrhoidal branch of the internal iliac artery, and the inferior hemorrhoidal branch of the internal pudic artery. The vessels assume a longitudinal direction toward the lower end of the rectum, and communicate very freely near the anus.

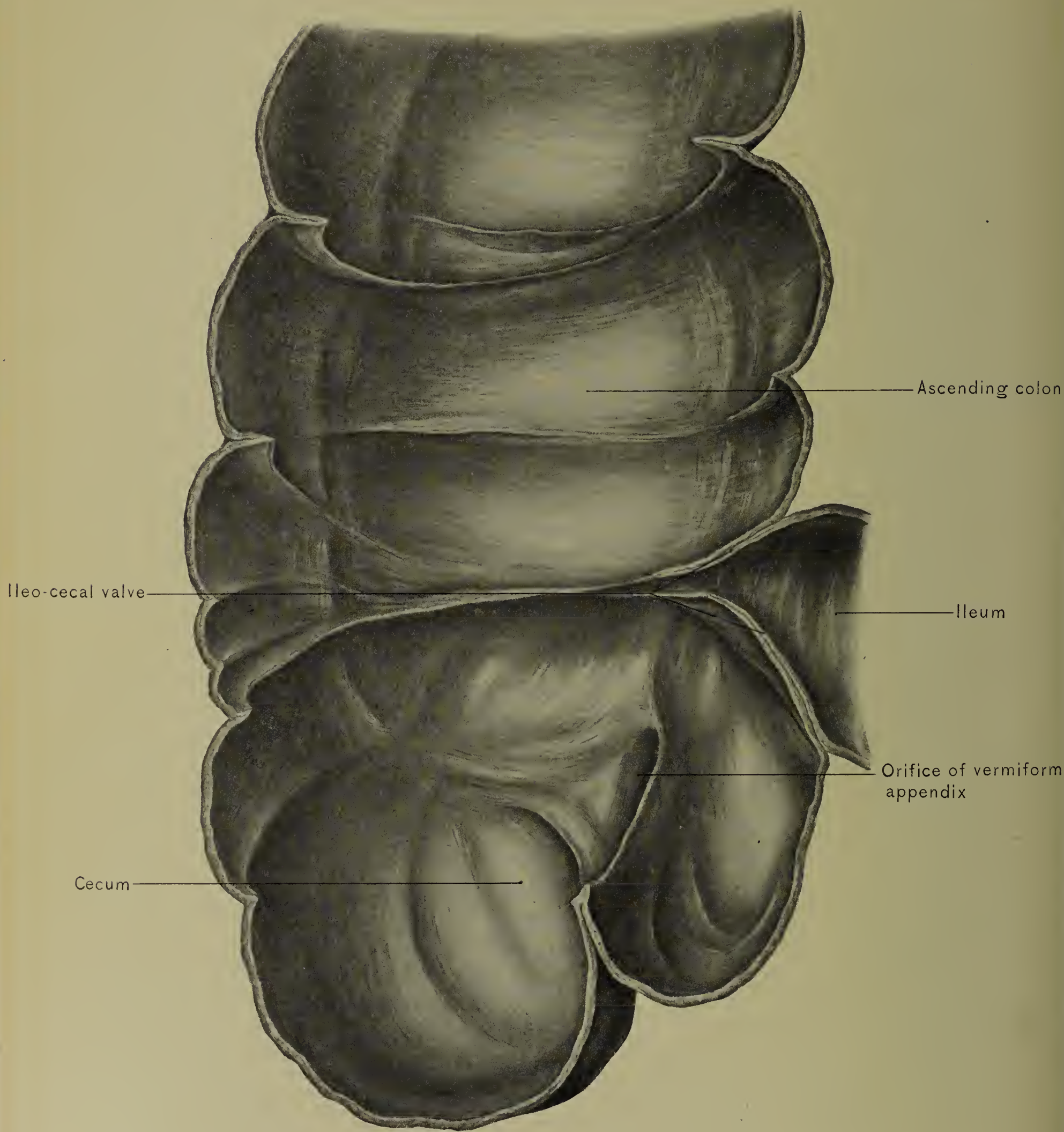
NERVE SUPPLY.—The nerves and lymphatics of the large intestine are similar to those of the small intestine.

The **ileo-cecal** or **ileo-colic valve** guards the orifice of communication between the ileum and colon and prevents regurgitation from the colon to the ileum. It consists of two transverse folds of mucous membrane, underlying which are submucous tissue and unstriated circular muscular fibers. The uppermost of the two folds is the smaller and more horizontal in position; the lower fold, the larger, is more vertical. To expose the valve an oval piece upon each side of it should be removed from both the ileum and the cecum.

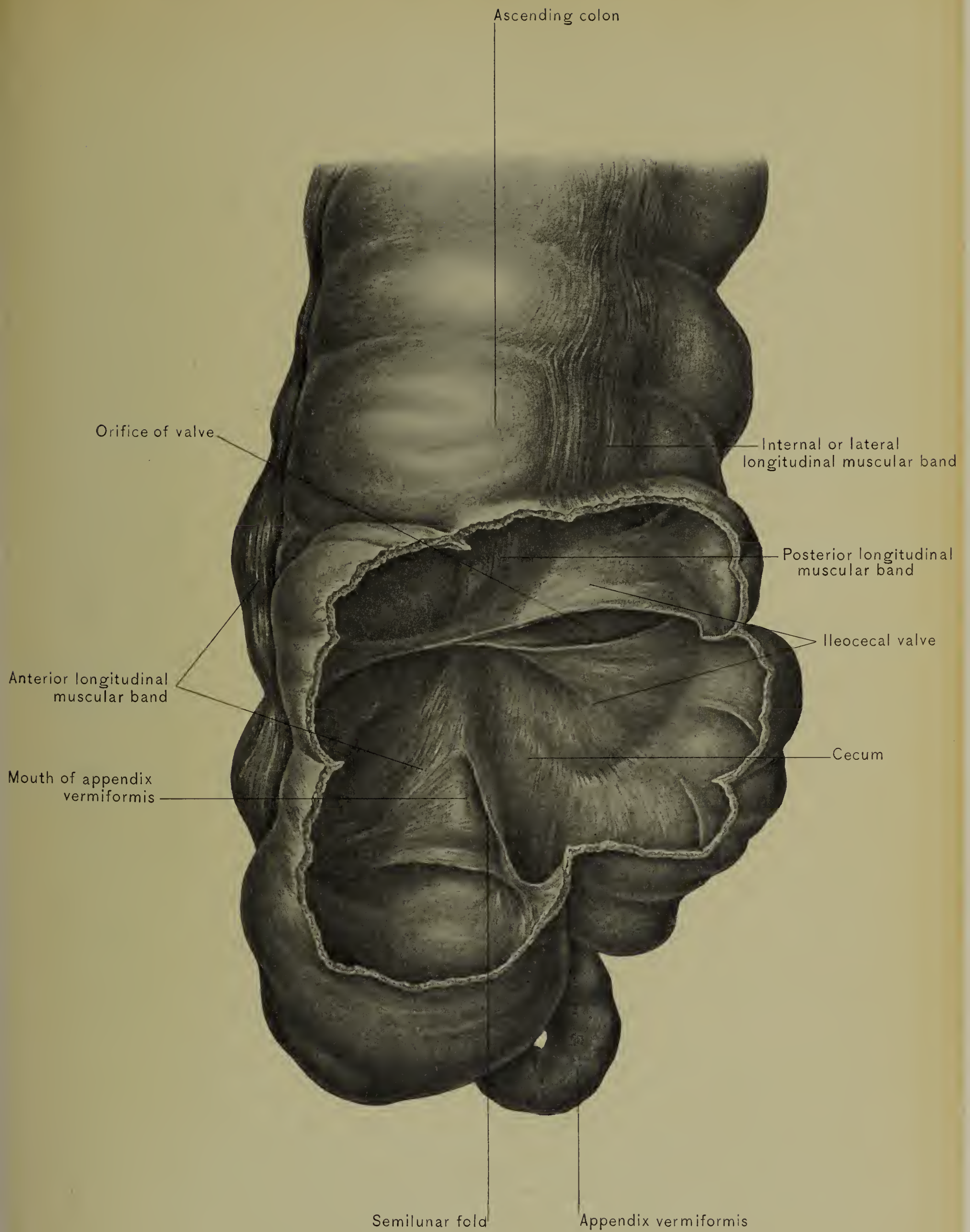
Intussusception.—The ileo-cecal region is probably the most frequent seat of that form of acute mechanical internal intestinal obstruction known as intussusception or invagination. Two varieties of invagination occur here—the ileo-



ILEO-CECAL VALVE,—EXTERNAL VIEW.



SECTION THROUGH ILEO-CECAL VALVE.



ILEO-CECAL VALVE,—INTERNAL VIEW.

cecal and the ileo-colic. In the more common variety,—the ileo-cecal form,—the ileum, the cecum, and the ileo-cecal valve are prolapsed into the colon, the ileo-cecal valve forming the summit of the protrusion. In the ileo-colic variety the ileum alone is prolapsed into the large intestine through the ileo-cecal valve.

Removal of the appendix is performed either during an attack of appendicitis or in the interval between two attacks. If done within a short time after the onset of the attack or in the interval between two exacerbations of the disease, the operation is comparatively safe and simple, but after the occurrence of gangrene of the organ or abscess, the mortality following the operation, as well as that of the disease, is high.

Incision and Operation.—In removing the appendix, the abdomen should be opened in the manner described in either of the following operations. In the old operation, the incision is made through the right semilunar line, the center of the incision passing through McBurney's point. The tissues divided are the skin, superficial fascia, aponeurosis of external oblique muscle, the aponeuroses of the internal oblique and transversalis muscles, or the anterior and posterior walls of the sheath of the rectus muscle and the transversalis fascia. This will expose the preperitoneal fat. In addition, a layer of interabdominal fascia will be incised between each two of the flat abdominal muscles. Two or three veins, tributaries of the deep epigastric artery, will be seen running through it. These should be avoided, if possible, but if cut, they can be readily tied. In suturing the abdominal walls these veins are sometimes punctured with the needle. The preperitoneal fat is separated along the line of the incision, and the anterior parietal peritoneum divided to the extent of only about one inch (three centimeters). One finger is introduced into the abdomen, the cecum located, and brought up to the bottom of the wound.

If the opening in the peritoneum is not large enough to permit of the necessary manipulation, it can readily be enlarged by dividing the parietal layer of that membrane over the finger with a pair of scissors. The author prefers to make the incision over the outer part of the rectus muscle and carry it through that muscle, so that the resulting scar will be thicker and stronger, and the probability of a ventral hernia through the cicatrix will be slight.

In McBurney's operation, the abdominal cavity is opened by a series of incisions. The first incision is semilunar in shape, and is made midway between the anterior superior spine of the ilium and the right semilunar line, and carried downward and slightly inward. It passes through skin, superficial fascia, and deep fascia. The fibers of the aponeurosis of the external oblique muscle are separated but not cut. The second incision passes through the superficial interabdominal fascia; the fibers of the internal oblique muscle are separated, the deep interab-

dominal fascia is divided, and the fibers of the transversalis muscle are separated. The third incision is parallel with the first, and divides the transversalis fascia, preperitoneal fat, and peritoneum. In closing the wound, each incision is closed separately. This operation is feasible when a small opening is sufficient. In cases of pus-formation or where much latitude is required, the incision through the rectus muscle is preferable, as the wound can be enlarged more conveniently.

The cecum is recognized by one or more of its longitudinal muscular bands, all of which lead to the base of the appendix when traced to the tip of the cecum. It is the practice of the author to deliver the cecum, when this can be done, and thus save time in searching for the appendix. As soon as the root of the appendix is located, the organ is traced to its tip and is then brought into the wound. The greater part of the cecum is now returned to the abdomen, and a small flat sponge or a piece of gauze is introduced to retain it.

Whether or not the appendix can be delivered or brought up into the wound will depend upon the number of adhesions, the width of the meso-appendix, etc. It is not possible in all cases to deliver the cecum immediately upon opening the abdomen, for the adhesions may tie it down, or the great omentum may cover it and be adherent to its outer wall or to the outer and anterior walls of the abdomen. The meso-appendix is next tied off, and the appendix disposed of by one of the now well-recognized surgical procedures. While the appendix can be removed through the linea alba, the cases in which the abdomen should be opened along this line are rare.

In acute appendicitis, where operation is not done until a mass or swelling appears in the right iliac fossa, the site of the incision should be governed by the position of the swelling. If the latter be more pronounced upon the outer than upon the inner side of the semilunar line, and comparatively low down, the author concludes that the appendix holds one of the right or outward positions, and is, therefore, more accessible through an incision carried obliquely through the anterior part of the flank, parallel with and above the outer third of Poupart's ligament.

In removal of the appendix for chronic or recurrent appendicitis the organ is frequently found to be encapsulated by a mass of inflammatory exudate. Under these circumstances the author has usually been able to find the appendix by burrowing through the exudate at the point where it is present in largest quantity. The method of searching for the appendix under such conditions is similar to that pursued in searching for the urethra when attempting a perineal section for traumatic stricture. In some cases of traumatic stricture of the deep urethra the perineum is virtually a mass of inflammatory exudate. Under these circumstances the author has always been able to find the urethra by dissecting through

the exudate where it was present in greatest amount, and where organization had advanced the furthest. It can readily be seen, from what has been said about the different positions of the appendix, how easily the surgeon who is not thoroughly familiar with the anatomy of the organ may be greatly embarrassed, if not entirely foiled, in his attempt at its removal.

When done for chronic or recurrent appendicitis, the operation for removal of the appendix is not, ordinarily, a difficult one. In removing the appendix for recurrent appendicitis, the most favorable time for performing the operation is in the interval between the attacks.

Colostomy, the establishment of an artificial anus by opening the colon, is most commonly performed upon either the descending colon or the sigmoid flexure, for the reason that the conditions requiring colostomy are most frequently the result of obstruction in either the sigmoid flexure or the rectum, and that the descending colon and sigmoid are situated nearest the anus.

When the descending colon is selected, the operation is performed by carrying an oblique incision through the loin (costo-iliac space), observing the oblique crease above the crest of the ilium; this is constant in all, and well marked in corpulent persons (Bryant). The line of the descending colon is drawn directly upward from a point half an inch (twelve millimeters) behind the center of the iliac crest. The following structures are divided: the skin, the superficial and deep fasciæ, the posterior fibers of the external oblique muscle, the anterior fibers of the latissimus dorsi muscle, the posterior fibers of the internal oblique and transversalis muscles, and the lumbar and transversalis fasciæ. On dividing the external oblique and latissimus dorsi muscles the lumbar fascia is immediately seen, an important landmark in any operation done through this space. After division of the lumbar fascia the posterior fibers of the internal oblique and transversalis muscles, the transversalis fascia, the extraperitoneal fat, and the outer or free border of the quadratus lumborum muscle are exposed. The colon is found anterior to the kidney and kidney fat, and is covered by a layer of fat arranged more compactly than the accumulation on the kidney, in which small veins are seen. The colon is found occupying the angular interval between the psoas and quadratus lumborum muscles. The layer of fat which covers the posterior part of the colon, where it is destitute of peritoneum, is then separated, and the bowel exposed. The index-finger is next carried behind the colon and into the angular interval between the psoas and quadratus lumborum muscles, and the bowel is brought to the bottom of the wound by rotating it outward upon its axis. This exposes the posterior wall of the descending colon, along which there is generally no peritoneum, thus making this operation extraperitoneal. By rotating the bowel the mucous membrane of the colon is projected well into the opening when made, thus afford-

ing the best possible spur. This spur acts as a valve between the portions of the gut above and below the opening, and prevents fecal matter from entering the lower portion. The posterior longitudinal muscular band is brought into view, and along this band the outer coats of the colon are transfixed with two sutures, about one and one-half inches (four centimeters) apart. These sutures hold the bowel in place while the opening into it is made.

When the sigmoid flexure is selected as the portion of the colon to be opened, the operation is called iliac, and not inguinal, colostomy. The sigmoid flexure is reached through the anterior abdominal wall, and is exposed through an oblique incision two and one-half to three inches (six to seven centimeters) in length. The center of the incision should correspond to its point of intersection with a line drawn from the anterior superior spine of the ilium to the umbilicus, and be carried through the abdominal wall one and one-half inches (four centimeters) to the inner side of the anterior superior spine of the ilium.

Right lumbar colostomy is performed only when the obstruction is too high to be relieved by either a left lumbar or a left iliac colostomy.

In the adult the meso-sigmoid, the reflection of peritoneum attaching the sigmoid flexure to the posterior wall of the abdominal and pelvic cavities, is longer than either of the meso-colons, and thus allows the sigmoid flexure to be drawn some distance from its normal site. In very young children it is well known that the sigmoid flexure and the meso-sigmoid are relatively much longer than in the adult, and that in a small percentage of cases the former will occupy the right iliac fossa; for this reason right iliac colostomy, in preference to left iliac colostomy, has been recommended in infants born with imperforate anus and in whom the rectum can not be found through an incision made in the perineum. This is no argument, however, against the left iliac operation, as even if the flexure does occupy the right iliac fossa, it can readily be found through the incision made in the left flank. The only anatomic reason for giving iliac colostomy the preference over lumbar colostomy is that in a certain percentage of cases the descending meso-colon is so long as to make it impossible to reach the colon through the incision in the loin. To offset this anatomic objection to the lumbar operation Mr. Bryant, in his Bradshaw Lecture on Colotomy, delivered in 1889, made the statement that in 170 cases of lumbar colostomy, on but one occasion did he fail to find the bowel through the ordinary loin incision. In this one instance, by prolonging the incision forward, he easily found the colon at the brim of the pelvis. This necessitated opening the peritoneum, which is always done in the iliac operation. The chief advantage offered anatomically by the lumbar over the iliac operation is that in the lumbar operation the absence of peritoneum on the posterior aspect of the colon overcomes the necessity of opening the peritoneal cavity.

DISSECTION.—At this point the topography of the duodenum, the pancreas, and the vessels in relation therewith are best studied. A blow-pipe should be introduced into the divided end of the jejunum. Before inflating the duodenum and stomach, however, the stomach should be lifted up, but not high enough to disturb the commencement of the duodenum, and the direction taken by the duodenum observed. The distended stomach should be displaced upward, and the posterior parietal peritoneum dissected up from where it has been divided in cutting through the transverse meso-colon. The duodenum and pancreas will now be seen throughout their extent, and the superior and inferior pancreatico-duodenal arteries will be found in the groove between the duodenum and the head of the pancreas.

The **Duodenum** is the first, the shortest, and the widest portion of the small intestine. Its length, which is ten to twelve inches (twenty-five to thirty centimeters) is less variable than that of the jejunum and ileum. It commences at the pyloric end of the stomach, and ends in the jejunum on the left side of the body of the second lumbar vertebra.

It consists of four portions. These are a first ascending, a descending, a transverse, and a terminal ascending portion.

The **first** or **first ascending portion** is nearly horizontal or transverse, and is about two inches (five centimeters) long. Like the stomach, this portion is comparatively movable: more so than any of the other portions of the duodenum. It passes upward, outward, and backward from the pyloric end of the stomach to the neck of the gall-bladder. Like the stomach, too, it is completely surrounded by the peritoneum, which, in turning to the right again, forms the free border of the gastro-hepatic omentum just above it. Situated above it are the foramen of Winslow and the lesser omentum; below, is the head of the pancreas; in front of it are the liver and the neck of the gall-bladder; and behind it are the common bile duct, the hepatic artery, the portal vein, and the gastro-duodenal artery. Owing to the relation which this portion holds to the gall-bladder its anterior surface is frequently found stained with bile after death.

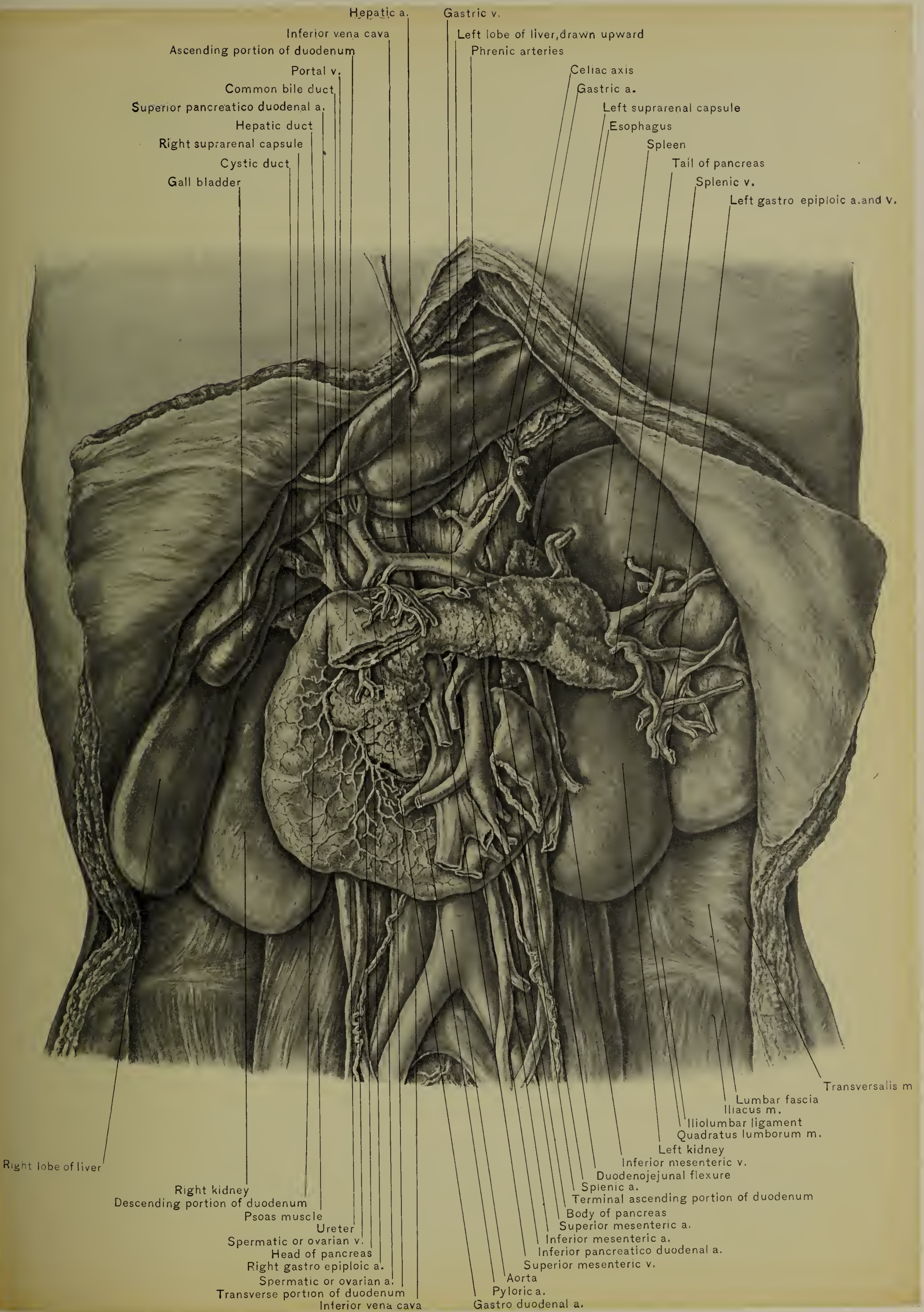
The **second** or **descending portion** is about three inches (seven centimeters) in length, and extends from the neck of the gall-bladder to the level of the third lumbar vertebra. It is covered with peritoneum—the ascending layer of the transverse meso-colon—on its anterior surface, except where the transverse colon passes in front of it, and is firmly fixed to the head of the pancreas by connective tissue and the peritoneum. In front of it is the commencement of the transverse colon; behind it are the common bile duct, the inner border of the right kidney, the renal vessels, and the inferior vena cava; on its inner, or left, side are the common bile and pancreatic ducts, both of which open into it, the superior and inferior pancreatico-duodenal arteries, and the head of the pancreas. After

obliquely traversing the wall of the bowel the pancreatic and common bile ducts open into the postero-internal aspect of the lower part of this segment of the duodenum, on the summit of a papilla.

The **third or transverse portion**, the longest and narrowest part of the duodenum, is about five inches (twelve centimeters) in length; it passes obliquely upward and toward the left side, across the vertebral column, at the third lumbar vertebra, to the left side of the second lumbar vertebra, where it terminates. A line drawn from a point three inches (seven centimeters) to the right of the umbilicus, to a point two inches (five centimeters) to the left and above it, will nearly indicate its position (Shield). Its anterior surface, except where the superior mesenteric artery and vein cross it, is covered by peritoneum—the descending layer of the transverse meso-colon. In front of it are the superior mesenteric artery and vein, the jejunum, and the lower layer of the transverse meso-colon; behind it are the crura of the diaphragm, the inferior vena cava, and the abdominal aorta; above it are the superior mesenteric artery and vein, the pancreas, and the inferior pancreatico-duodenal artery; below it are parts of the mesentery and posterior parietal peritoneum.

The **fourth or terminal ascending portion** is the shortest portion, being about one inch (2.5 centimeters) in length. It commences immediately to the left side of the second lumbar vertebra, passes upward on the surface of the left psoas muscle, and terminates at the point where the mesentery begins—namely, at the origin of the jejunum. It is covered by peritoneum on the anterior surface and partly on the sides, and is firmly fixed to the left crus of the diaphragm and the connective tissue around the celiac axis by a band of fibrous tissue which contains some muscular tissue as well, and is called the *musculus suspensorius duodeni*, or suspensory ligament of the duodenum and mesentery. The junction of the terminal portion of the duodenum with the jejunum constitutes the *duodeno-jejunal bend*, below and to the left of which is the duodeno-jejunal fossa. The fossa duodeno-jejunalis has been described with the peritoneum.

Surgery of the duodenum.—Being destitute of peritoneum posteriorly, the duodenum beyond the first portion may be wounded from behind without opening the peritoneal cavity. The relations which the duodenum bears to the liver, gall-bladder, common bile duct, kidney, colon, pancreas, aorta, and vertebral column must be borne in mind in order to explain the origin of certain complications, as well as sequelæ consequent upon disease of any of these organs. From the relation that the gall-bladder bears to the duodenum it may be understood how, by ulcerative perforation, a communication may be established between them, thus making a spontaneous cholecysto-duodenostomy, by way of which gall-stones too large to pass through the cystic and common bile ducts may reach the duodenum.



DUODENUM AND PANCREAS.

This relation, together with the fact that the first portion of the duodenum is quite freely movable, affords the surgeon, through the operation of cholecysto-duodenostomy, a means of relieving a patient who is the subject of obstruction of the common bile duct by a growth involving the head of the pancreas or the duodenum at the site of the papilla of Vater, in cases where neither of them can be removed. Ulceration of the first portion of the duodenum is a very rare complication of burns of the second degree. If the ulceration progress until perforation has taken place, the peritoneal cavity will usually be opened.

The **Pancreas** is a long, slender organ extending from the second portion of the duodenum through the epigastric region, to the hilum of the spleen, in the left hypochondriac region. It measures from six to eight inches (fifteen to twenty centimeters) in length, from one to one and one-half inches (2.5 to 4 centimeters) in breadth, and from one-half to one inch (1 to 2.5 centimeters) in thickness, and weighs, on an average, about three ounces (eighty-five grams). It is composed of three portions—a head, a body, and a tail. The head is the largest portion, and is embraced in the concavity of the curve formed by the first, second, and third portions of the duodenum; the body crosses the bodies of the first and second lumbar vertebræ, and in front of the great vessels, and has an anterior, a posterior, and an inferior surface; the tail is in contact with the anterior margin of the hilum of the spleen.

It is a compound racemose gland which resembles the salivary glands in structure, although it is looser and softer in texture. It is surrounded by a layer of areolar tissue which binds the different lobules of the gland together by dipping down between them. The **duct of the pancreas (duct of Wirsung)** runs almost the whole length of the gland within its substance, and it receives, along its course, numerous tributaries which join the main duct at right angles. These tributaries subdivide, the terminal divisions ending in a number of acini which form the separate lobules. The duct empties into the second portion of the duodenum, generally in common with the common bile duct. This duct may become occluded by a calculus and thus give rise to symptoms simulating biliary colic.

RELATIONS.—In front of the pancreas are the ascending layer of the posterior parietal peritoneum and the stomach. Behind it are the crura of the diaphragm, the inferior vena cava, the aorta, the splenic artery and splenic vein, the origin of the superior mesenteric artery, the terminations of the superior and inferior mesenteric veins, the commencement of the portal vein, the left renal vein, the left kidney and suprarenal capsule. Above it are the celiac axis and the hepatic and the splenic artery. The lower surface is narrow and is in contact with the transverse portion of the duodenum, the duodeno-jejunal flexure, the transverse colon, and the transverse meso-colon.

BLOOD SUPPLY.—The blood supply of the pancreas is derived from the pancreatic branches of the splenic and hepatic arteries, and from the superior and inferior pancreatico-duodenal arteries. The veins of the pancreas empty into the splenic and superior mesenteric veins.

NERVE SUPPLY.—The nerve supply of the pancreas is derived from the solar plexus. These nerves accompany the arteries.

Surgery of the pancreas.—From the relation which the pancreas holds to the stomach it can be understood why it is so often involved in carcinoma of the posterior wall of the stomach. At times, also, it is the site of primary carcinoma which, if it involve the head of the organ, may cause occlusion of the common bile duct and consequent jaundice. If it affect that part of the organ in relation with the aorta or in immediate proximity thereto, it may simulate aortic aneurysm by causing a swelling, over which pulsation, transmitted to it by the aorta, is detected. When a pancreatic cyst assumes large size it may be mistaken for an ovarian cyst. The pancreas, or a growth thereof, is most readily reached by displacing the great omentum, transverse colon, and transverse meso-colon upward and dividing the lower layer of the transverse meso-colon. The pancreas has rarely been a constituent of a diaphragmatic hernia.

The **splenic artery**, the largest branch of the celiac axis, runs tortuously along the upper border of the pancreas, and reaches the hilum of the spleen by passing between the layers of the lienorenal ligament.

The **branches of the splenic artery** are the pancreaticæ parvæ, pancreatica magna, vasa brevia, left gastro-epiploic, and terminal branches.

The **pancreaticæ parvæ** are small branches that arise from the splenic artery in its course above and beneath the pancreas. They enter and supply the pancreatic tissues.

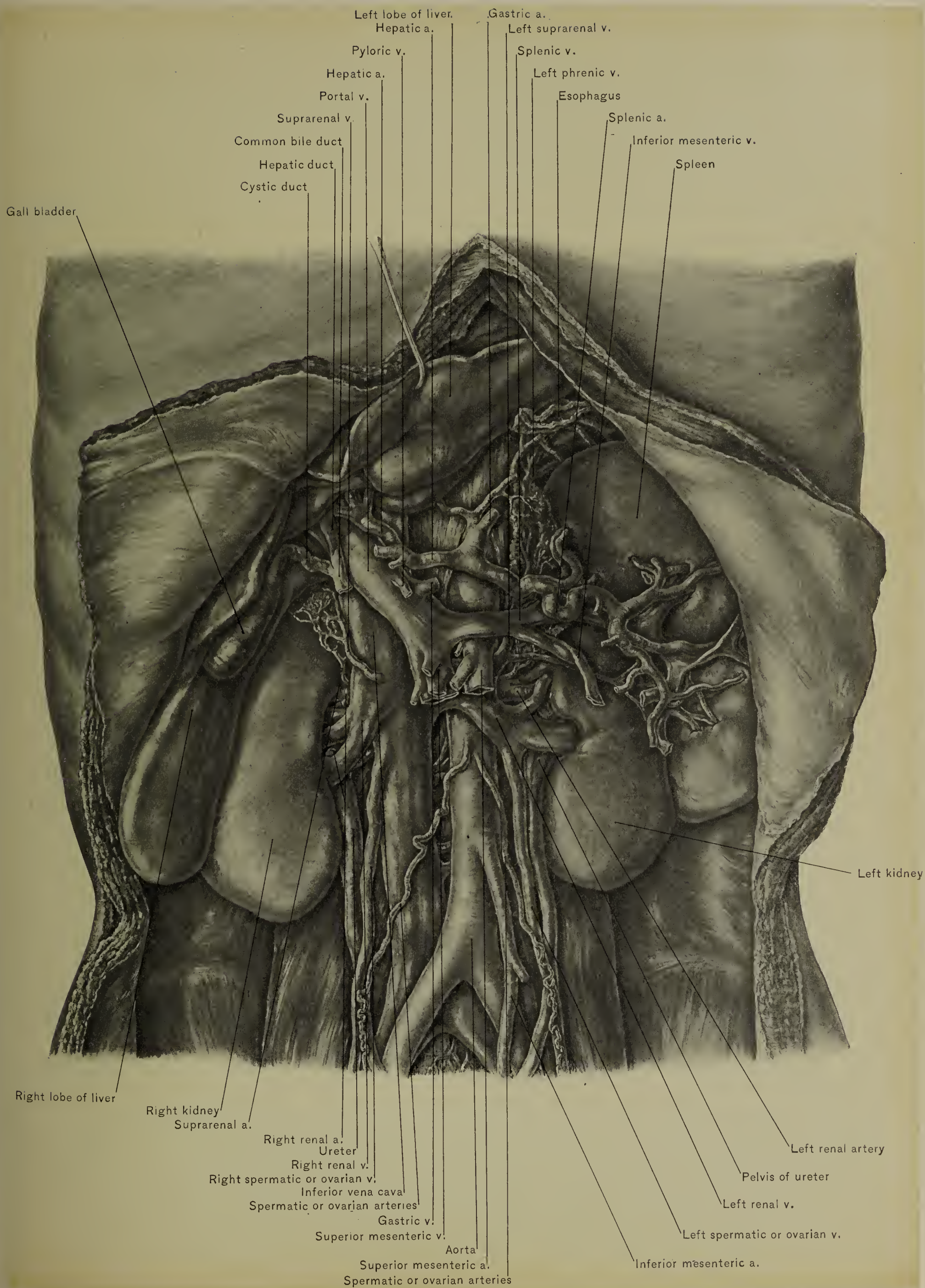
The **pancreatica magna** is given off near the tail of the pancreas, runs from left to right, and accompanies the pancreatic duct.

The **vasa brevia** arise from the terminal part of the splenic artery or its terminal branches, pass to the cardiac end of the stomach, between the layers of the gastro-splenic omentum, and anastomose with branches of the gastric and the left gastro-epiploic artery.

The **left gastro-epiploic artery**, the largest branch of the splenic, runs from left to right along the greater curvature of the stomach, between the descending layers of the great omentum, where it anastomoses with the right gastro-epiploic artery.

DISSECTION.—The pancreas and the splenic artery should be displaced downward and forward in order to expose the splenic vein.

The **splenic vein** is of large size, and runs behind the pancreas and below the



PORTAL VEIN, SUPERIOR AND INFERIOR MESENTERIC VEINS, AND SPLENIC VESSELS.

splenic artery, to join the superior mesenteric vein, with which it forms the portal vein. Unlike the splenic artery, the vein pursues a direct course. It receives the inferior mesenteric vein and branches corresponding to those of the splenic artery.

DISSECTION.—The pancreas should be displaced forward and upward, and the commencement of the superior mesenteric artery, the terminations of the superior and inferior mesenteric veins, and the beginning of the portal vein exposed.

The **superior mesenteric artery** arises from the front of the aorta, a short distance below the celiac axis, and sometimes as a common trunk with the axis. It runs downward behind the pancreas and the splenic vein, and then forward between the lower surface of the pancreas and the third portion of the duodenum, to enter the mesentery.

The **inferior pancreatico-duodenal artery** arises from the superior mesenteric artery, behind the lower margin of the pancreas. It takes a curved course around the head of the pancreas, between it and the duodenum, and supplies branches to both. It terminates by anastomosing with the superior pancreatico-duodenal artery.

The **superior mesenteric vein**, the accompanying vessel of the superior mesenteric artery, runs a short distance in front and to the right of this artery. Like the superior mesenteric artery it passes between the third portion of the duodenum and the lower surface of the pancreas, then behind the pancreas, at the upper border of which it joins the splenic vein in front of the inferior vena cava, to form the portal vein.

The **inferior mesenteric vein**, the accompanying vessel of the inferior mesenteric artery, runs upward beneath the posterior parietal peritoneum, as already described. It passes along the left side of the third portion of the duodenum, and then behind the pancreas, to join the splenic vein on the left side of the point of union of the latter vein with the superior mesenteric vein.

DISSECTION.—The liver should now be removed, so that it may be more fully studied. First, the round and suspensory ligaments are to be divided, and, after drawing the liver downward, the lateral ligaments of the organ should be severed, and the upper or anterior layer of the coronary ligament. Next that portion of the posterior surface which is connected to the diaphragm by areolar tissue should be separated from its attachment. The liver being now displaced further downward, the inferior vena cava will be seen emerging from the posterior surface of the liver, on its way to pierce the central tendon of the diaphragm, just below which the inferior vena cava should be severed. Then the remaining or inferior layer of the coronary ligament should be divided, and the inferior vena cava at the level of the under surface of the liver severed. After severing the structures which traverse the transverse fissure of the liver, and separating the gall-bladder from the right lobe, the liver may be lifted out of the abdominal cavity.

The **Liver**, the largest gland in the body, weighs about fifty ounces (1425 grams). It is of firm consistence and of a reddish-brown color. Its main bulk lies in the right hypochondriac region, although it extends through the epigastric, and sometimes into the left hypochondriac, region. It occupies the entire antero-posterior diameter of the abdominal cavity. In the child the liver is proportionately much larger than in the adult. It fits closely into the concavity of the diaphragm above, its superior and posterior surfaces being in contact with that muscle.

The plasticity of the liver is so great that its shape changes considerably after it has been removed from the body and laid on a flat surface. On the surface of a liver which has been hardened *in situ*, the various depressions for the different organs which abut against it are plainly seen, and the fissures and lobes are more distinct in their outlines. The liver has three surfaces, one border, two extremities, five lobes, five fissures, five ligaments, and five sets of vessels.

The **Surfaces of the Liver** are the superior, the inferior, and the posterior.

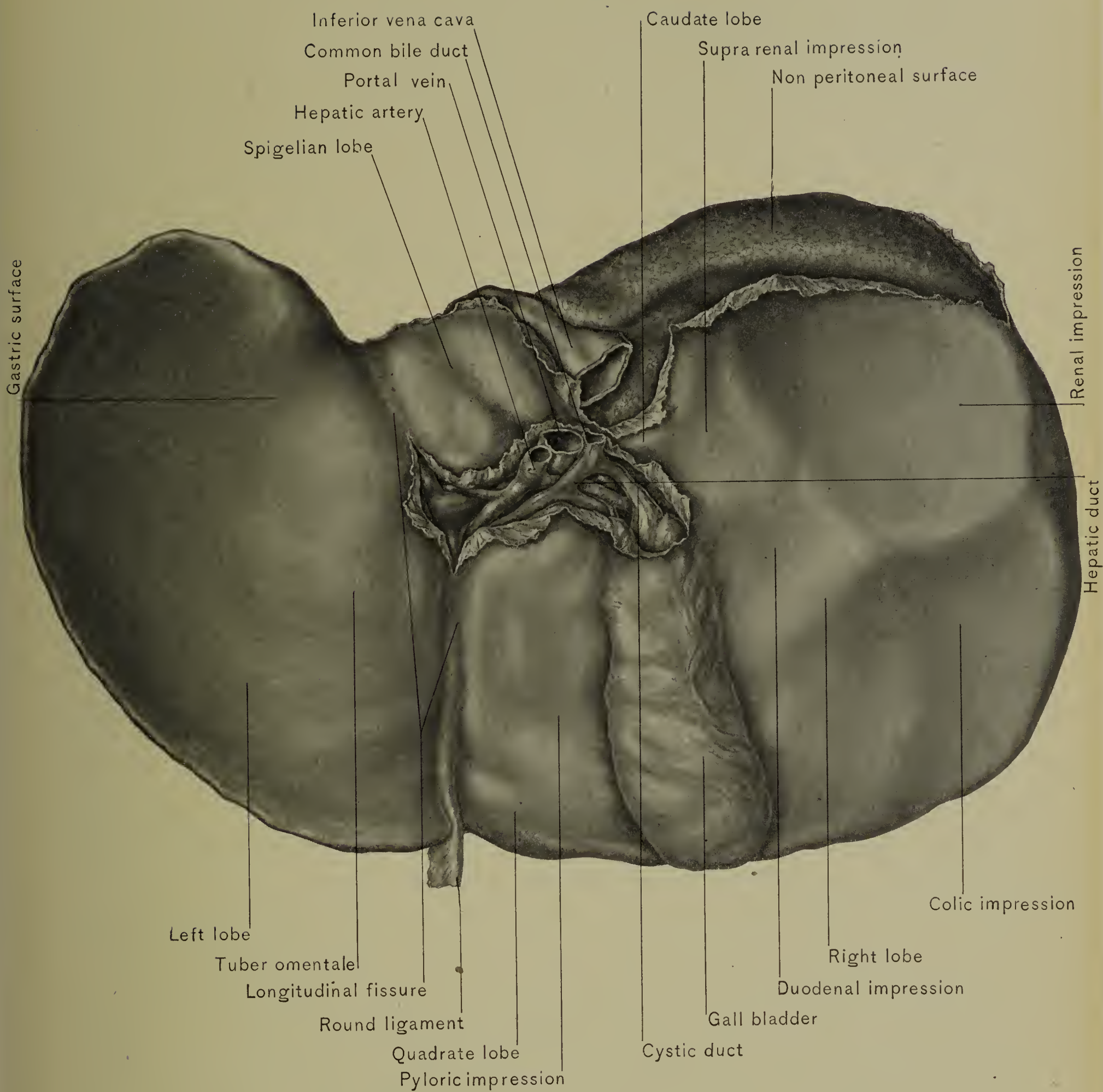
The **superior surface** lies against the diaphragm, to which and to the anterior abdominal wall it is attached by the suspensory ligament. It is convex and smooth, and is entirely covered by peritoneum. The suspensory ligament is attached along its antero-posterior diameter, dividing the surface into two divisions which represent the superior surface of the right and the left lobe.

The **inferior surface** is very irregular, being subdivided by fissures and vessels, and it, too, is entirely covered with peritoneum except where the gall-bladder lies in contact with this surface and at the transverse fissure. A longitudinal sulcus divides it into a right and a left lobe.

The **posterior surface** is irregularly concave from side to side, the concavity being due to pressure against the vertebral column. Slightly to the right of the concavity will be found the inferior vena cava embedded in the liver. To the right of the inferior vena cava this surface of the liver is rough and not covered by peritoneum, and connected with the diaphragm by the connective tissue situated between the two layers of the coronary ligament. The part of this surface represented by the right lobe is broad, while that corresponding to the left lobe is narrow. The right extremity is thick and rounded, while the left is thin and flattened.

The **Fissures of the Liver** are arranged in the form of the letter **H**, and so placed that they divide the liver into the various lobes. They are the longitudinal fissure, which is subdivided into the umbilical fissure, and the fissure for the ductus venosus, the transverse fissure, the fissure for the gall-bladder, and the fissure for the inferior vena cava. They are found on the inferior and posterior surfaces.

The **longitudinal fissure** extends from the notch in the anterior border of the



INFERIOR SURFACE OF LIVER.

liver to the posterior surface, separating the right and left lobes. It is joined at right angles by the transverse fissure, which divides it into two unequal parts. The anterior of these is the deeper of the two. It lodges the umbilical vein in the fetus, and its remains, the round ligament, in the adult; it is therefore called the **umbilical fissure**. It is at times bridged over by a piece of the hepatic substance, the *pons hepatis*. The posterior portion of the longitudinal fissure lodges the ductus venosus in the fetus, and in the adult a small, fibrous cord, the remains of this vessel. It is shallower than the anterior portion, and is known as the **fissure of the ductus venosus**.

The **transverse fissure** (portal) is deep, and about two inches (five centimeters) in length; it extends transversely to the right from the longitudinal fissure, and is situated about midway between the anterior border and the posterior surface of the liver. It gives passage to the hepatic artery and nerves, the hepatic duct, the portal vein, and the lymphatics. Just below the fissure the vessels hold a definite arrangement, the duct lying to the right of the artery, with the portal vein between and behind them.

The **fissure or fossa of the gall-bladder** is a shallow depression found on the inferior surface of the right lobe. It extends from the anterior margin to near the right extremity of the transverse fissure. It lies parallel with the longitudinal fissure.

The **fissure for the inferior vena cava** is found to the right of the Spigelian lobe, this part of the liver separating it from the longitudinal fissure. It is very short and deep, and is sometimes bridged over by liver substance, when it forms a complete canal. Its course is oblique.

The **Lobes of the Liver** are the right, the left, the quadrate, the Spigelian, and the caudate. The number of lobes may be increased or diminished according to the number of fissures present. Sömmerring has described a liver which was so fissured that it had twelve distinct lobes. An entirely separate and distinct "accessory liver," composed of true liver substance, is sometimes found hanging from the left lobe.

The **right lobe** forms the main bulk of the organ, comprising fully four-fifths of the entire mass. It is separated from the left lobe, above, by the line of attachment of the suspensory ligament; below, by the longitudinal fissure; and in front, by a deep notch. The under surface has a fossa for the gall-bladder and two shallow impressions. The anterior or *colic impression* rests upon the hepatic flexure of the colon, and the posterior or *renal impression* upon the right kidney; faint impressions for the duodenum and the suprarenal body may likewise be recognized. This surface presents, too, the three smaller lobes—the Spigelian, the quadrate, and the caudate.

The **left lobe** is not so large as the right in any of its diameters, and is more nearly flat. It is found in the epigastric region, and rarely extends more than six centimeters ($2\frac{1}{2}$ inches) beyond the left margin of the sternum, although it may extend into the left hypochondriac region. It overlaps and almost completely covers the stomach when that organ is not distended. The posterior surface of this lobe is notched for the esophagus. To the left of this notch, on the inferior surface, is the shallow *gastric impression* for the stomach. Between this depression and the longitudinal fissure is found a slight elevation, the *omental tuberosity*, which lies against the lesser omentum and the lesser curvature of the stomach.

The **Spigelian lobe** extends from the transverse fissure to the posterior surface of the liver, and between the fissures for the inferior vena cava and the ductus venosus. It is found in the concavity of the posterior surface of the liver, being separated from the spinal column by the diaphragm and the aorta.

The **quadrate lobe** is found on the inferior surface of the right lobe, between the umbilical fissure and the fissure for the gall-bladder, and extends from the anterior border of the liver to the transverse fissure. It is in relation with the pyloric end of the stomach and the first part of the duodenum.

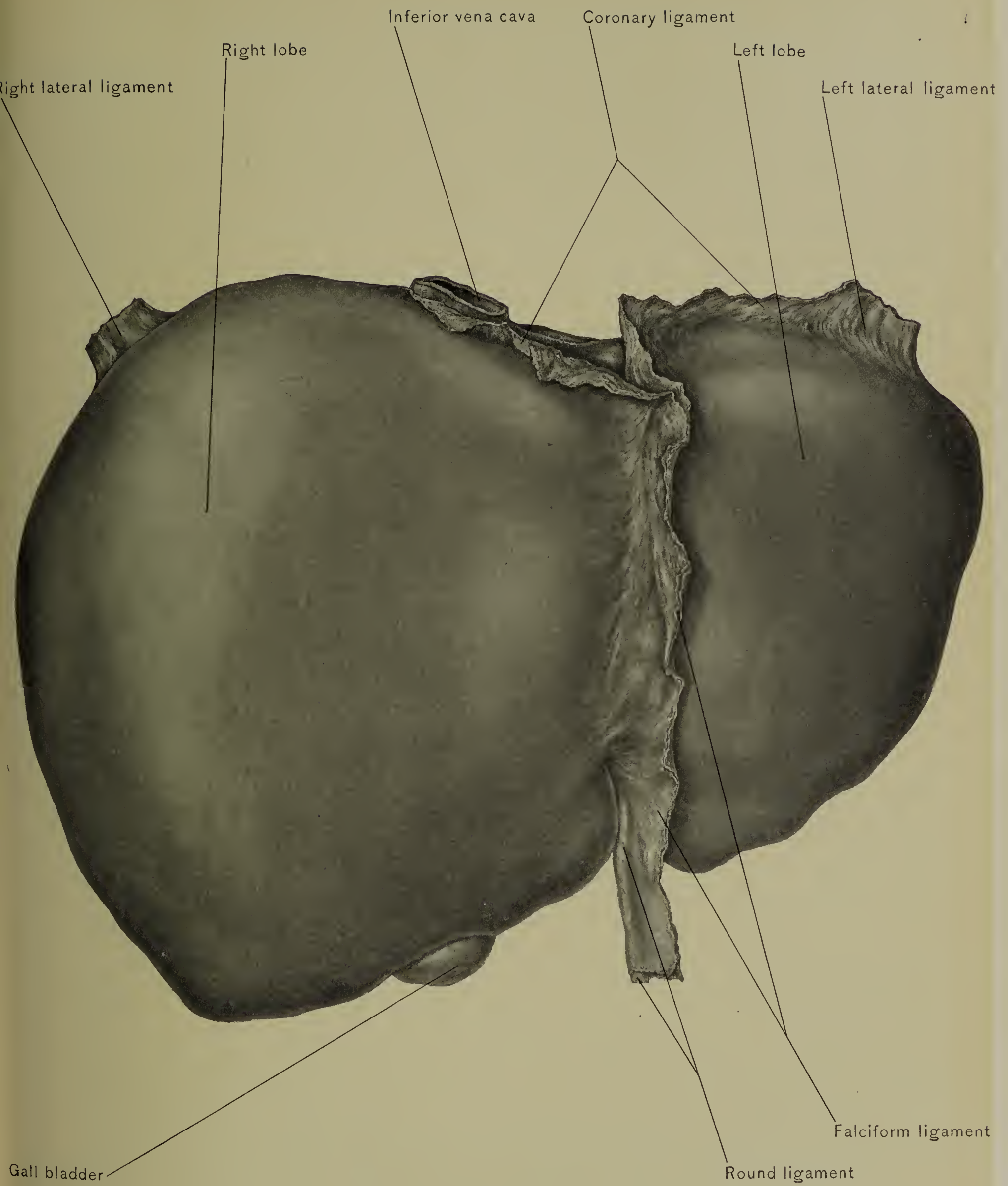
The **caudate lobe** is a narrow eminence which extends obliquely forward and to the right from the base of the Spigelian lobe to the inferior surface of the right lobe. It separates the fissure for the inferior vena cava from the right end of the transverse fissure.

The **Five Sets of Vessels of the Liver** are the hepatic artery, the portal vein, the hepatic duct, the lymphatic vessels, and the hepatic veins. The first three lie together at the transverse fissure, the vein being behind the other two, and the duct to the right of the artery. They are covered by the capsule of Glisson, and are accompanied by nerves and lymphatics.

The **hepatic veins** are venous channels within the liver which do not extend beyond its substance. They empty directly into the inferior vena cava at the point where it is apposed to the liver, and the inferior vena cava is firmly attached to the liver by these hepatic veins and by fibrous tissue.

The **Lymphatics of the Liver** are superficial and deep.

The **superficial lymphatics** are found in the subperitoneal connective tissue covering the entire organ, and consist of several groups: (1) Three or four branches pass forward upon the top of the liver and into the suspensory ligament, where they unite into a single trunk which enters the chest through the small diaphragmatic opening at the side of the xiphoid cartilage, to join the anterior mediastinal glands, eventually emptying into the right lymphatic duct. (2) A similar group turns downward over the anterior border of the liver to its under surface, runs along the longitudinal fissure to the transverse fissure, and



SUPERIOR SURFACE OF LIVER.

thence to the glands of the gastro-hepatic omentum. (3) Some lymphatics pass over the superior surface of the liver to its right lateral ligament, where they either pierce the diaphragm and cross to the left and enter the anterior mediastinal glands, or pass to the left over the right crus of the diaphragm to enter the lower end of the thoracic duct. (4) Other lymphatics pass toward the left, along the superior surface of the left lobe, to the left lateral ligament, where they perforate the diaphragm and pass forward to the anterior mediastinal glands. (5) The lymphatics from the right of the gall-bladder on the under surface empty into the lumbar glands. (6) The lymphatics surrounding the gall-bladder form a plexus and pass to the glands of the gastro-hepatic omentum. (7) Those glands from the under surface of the liver upon the left of the gall-bladder pass to the esophageal glands and to the glands along the lesser curvature of the stomach.

The **deep lymphatics** accompany the portal and hepatic veins through the liver. The portal lymphatics enter the glands of the lesser omentum; those which follow the hepatic veins pass through the canal opening in the diaphragm and enter the thoracic duct.

BLOOD SUPPLY.—The blood supply of the liver is derived from the hepatic artery and the hepatic branch of the gastric artery.

NERVE SUPPLY.—The nerve supply of the liver is derived from the hepatic plexus of sympathetic nerves, which receives filaments from the left pneumogastric and right phrenic nerves. It accompanies the ramifications of the hepatic artery through the liver substance, and sends branch plexuses along the pyloric and gastro-epiploic arteries. A *cystic branch* for the gall-bladder is also derived from the hepatic plexus.

The fact that the right phrenic nerve sends branches to the liver is of interest in connection with the “shoulder-tip pains” of certain hepatic affections. The phrenic nerve is derived mainly from the fourth cervical nerve, which also sends a branch—the supra-acromial—to the integument at the summit of the shoulder.

Structure of the liver.—The structural arrangement of the liver is comparable to many clusters of grapes so closely packed together that the mutual pressure would give the fruit a polyhedral form, and so that a section would show the grapes polygonal and edge to edge. Each grape would represent a liver lobule through the center of which passes a vein called the central or intralobular vein. The stems which support the grapes would represent the sublobular veins into which the central veins empty, while the larger stalks formed by the union of many branches would represent the hepatic veins which eventually enter the inferior vena cava. The interspaces between the compressed polygonal grapes would correspond to the interlobular spaces of

the liver, in which are found the branches of the hepatic duct and of the afferent vessels—*i. e.*, the portal vein and the hepatic artery. The hepatic artery and portal vein form a network about each lobule, from which small vessels penetrate the lobule, those from the artery for nourishment, and those from the portal vein to bring work, all of which is done in the short transit of blood from the periphery to the center of the lobule. This arrangement of the liver is simple, readily understood, and when once mastered is the key to a number of important pathologic facts which it is otherwise difficult to remember.

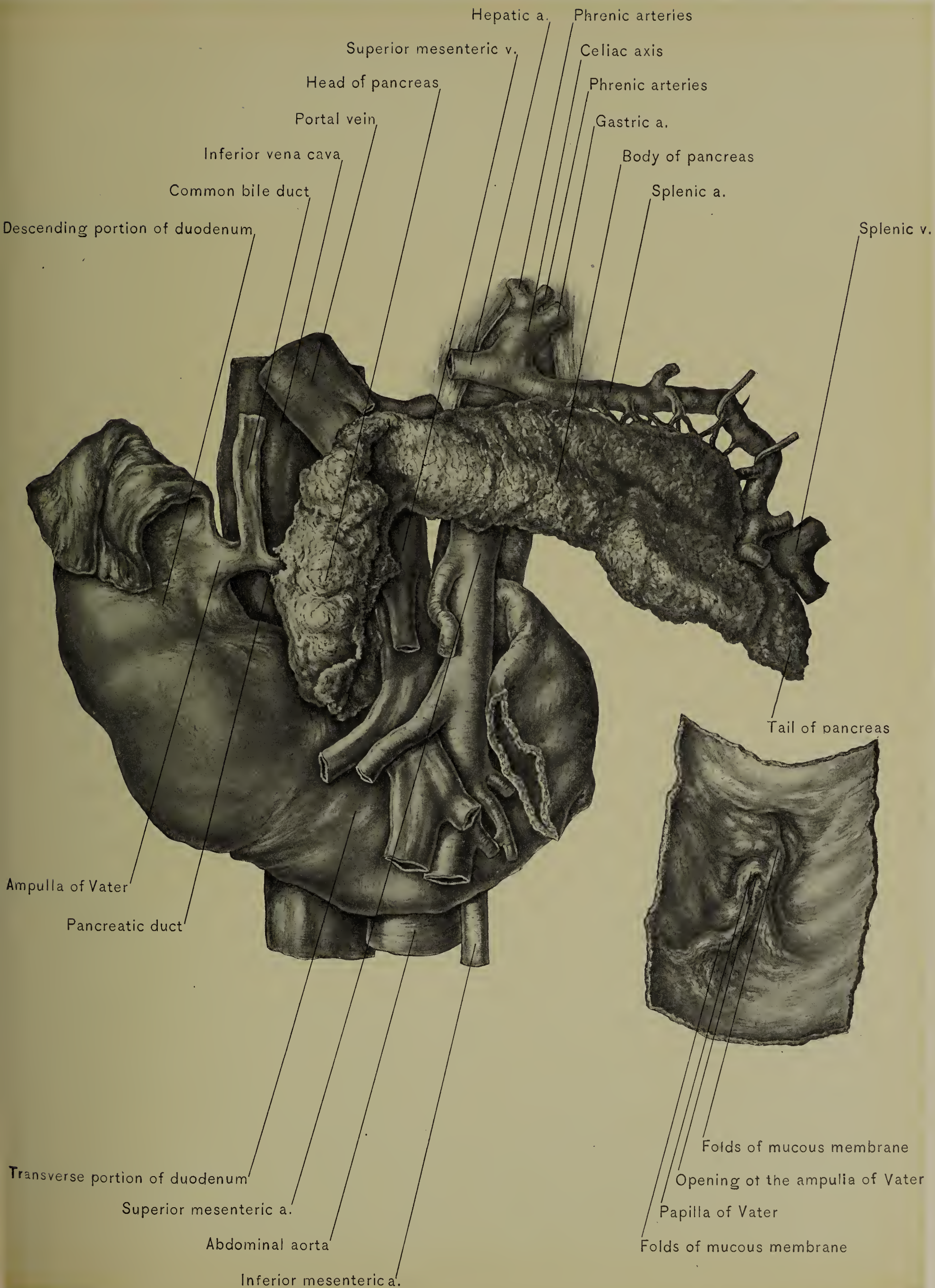
The **Gall-bladder** is a pear-shaped viscus about four inches (ten centimeters) long and about one and a half inches (four centimeters) wide at its widest part, and its capacity is about one and one-fourth ounces (forty cubic centimeters). To facilitate description it is divided into a fundus, a body, and a neck. The **fundus** projects slightly beyond the anterior margin of the liver, between the right and square lobes, and just below the chondral margin, opposite the ninth costal cartilage, or at the intersection of the costal margin and the outer border of the right rectus muscle. The **body and the neck** are directed backward, upward, and to the left. The neck presents a curve like the letter **S**, and, becoming narrower, ends in the cystic duct. The gall-bladder is a fibro-muscular sac lined with mucous membrane and covered with peritoneum, which passes from its sides upon the adjoining surface of the liver; the gall-bladder is sometimes, however, wholly invested by peritoneum, which may form a sort of mesentery for it. The mucous membrane of the neck and of the cystic duct is arranged in a spiral fold—valve of Heister—which prevents the sudden expulsion of its contents. The gall-bladder is very tough—so much so, in fact, that if it be taken out of a fresh body, inflated, and then permitted to dry, a man of average weight may stand upon it without rupturing its walls.

RELATIONS.—Above the gall-bladder is the under surface of the liver; below it are the first portion of the duodenum, the hepatic flexure of the colon, and, at times, the pyloric end of the stomach. The fundus abuts against the anterior abdominal wall just below the ninth costal cartilage.

Structure of the gall-bladder.—The walls of the gall-bladder are composed of three coats—a serous, a fibro-muscular, and a mucous.

The **serous coat** is derived from the peritoneum. As was observed in the dissection of that membrane, the peritoneum completely surrounds the fundus of the gall-bladder, but is found only on the lateral and under surfaces of the body and neck.

The **fibro-muscular coat** is composed of a strong layer of fibrous tissue, the fibers interlacing in all directions to form a network. The muscular fibers inter-



PANCREATIC AND COMMON BILE-DUCTS.



PANCREAS AND DUODENUM, WITH PANCREATIC AND COMMON BILE-DUCTS.

mingle with the fibrous tissue. They run principally in a longitudinal direction, although some are placed transversely.

The **mucous coat** is of a yellowish-brown color, and of the form of a mesh-work, formed by the membrane being thrown into numerous rugæ. By an inward projection of the mucous layer a valve is formed opposite the neck of the gall-bladder.

The **common excretory duct of the liver**, the **ductus communis choledochus**, is formed by the junction of the cystic and hepatic ducts, about half an inch (one centimeter) above the upper margin of the first portion of the duodenum. The **cystic duct** leaves the neck of the gall-bladder and passes obliquely downward for about an inch and a half (four centimeters), to join the hepatic duct. The **hepatic duct** is formed by two ducts of about equal size which leave the liver through the transverse fissure. Both the hepatic and cystic ducts traverse the gastro-hepatic omentum. The common bile duct descends between the layers of the lesser omentum on the right side of the hepatic artery, runs behind the first part of the duodenum, and passes along the postero-internal aspect of the second portion of the duodenum, where it lies embedded in the sulcus between that portion of the duodenum and the head of the pancreas. It is joined by the pancreatic duct, and then passes obliquely through the duodenal wall, and opens into the duodenum on the summit of an elevation on the inner aspect of the gut (papilla of Vater), about four inches (ten centimeters) from the pylorus. The intestinal orifice is somewhat constricted; just above the orifice of the duct it presents a dilatation, the *ampulla of Vater*, in which biliary calculi passing down the duct may lodge.

Structure.—The walls of the bile ducts are composed of two layers—an external or fibrous coat and an internal or mucous coat. The external layer is made up of fibro-areolar tissue with a few muscular fibers arranged in a circular direction. The mucous coat is continuous with the mucous coat of the gall-bladder and that of the two ducts forming the hepatic duct, and also with the mucous membrane of the duodenum. There are many mucous glands found in the mucous membrane.

The gall-bladder may be distended with calculi. Some surgeons have forced these out through the ducts into the intestinal canal simply by kneading. This is a dangerous procedure, the operation upon the gall-bladder being the more common method of relief.

Cholecystenterostomy is an operation which establishes a communication between the gall-bladder and the intestine when the common bile duct is obstructed. The incision can be made through the right semilunar line, on a level with the tenth costal cartilage. It divides the skin, superficial fascia, aponeuroses of the external oblique, internal oblique, and transversalis muscles,

transversalis fascia, preperitoneal fat, and peritoneum. The incision is preferably made through the right rectus muscle. The gall-bladder is then found and drawn into the wound if possible. It should be incised and carefully cleaned. The duodenum should next be brought into the wound, and as high a portion of it as possible incised. The wounds in the duodenum and gall-bladder should then be approximated and held in apposition by two rows of sutures. The first row is a continuous Lembert suture which unites the serous coats of the duodenum and gall-bladder posteriorly. The second row is then introduced from within and secures the cut edges of the mucous membranes, after which the continuous Lembert suture is completed. The parietal wound is then closed in the usual manner. The preferable operation is that done by employing the Murphy button.

DISSECTION.—The lower end of the esophagus, the phreno-splenic ligament, and any remaining portions of the peritoneum which are attached to the stomach, spleen, duodenum, or pancreas should be divided and these organs removed from the abdominal cavity. This will permit a thorough study of the structure of these organs.

Structure of the Stomach.—The walls of the stomach are made up of four coats—the serous, the muscular, the submucous, and the mucous.

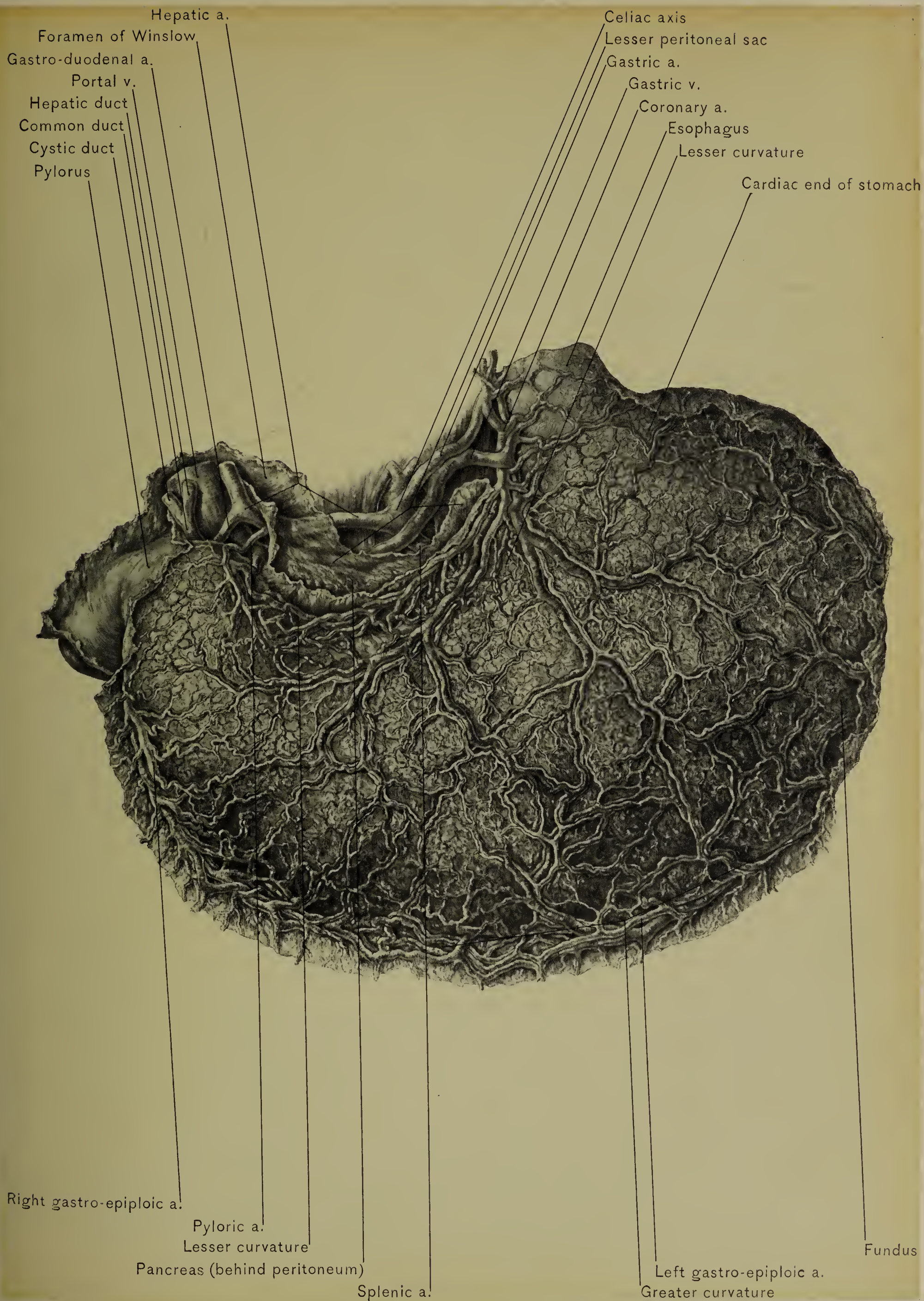
The **serous coat of the stomach** has been studied with the peritoneum. It will be remembered that the peritoneum entirely surrounds the stomach, with the exception of the curvatures, where there is a linear interval between the two layers of the omenta.

The **muscular coat of the stomach** is exposed by removing the serous coat. It consists of unstriated muscular fibers arranged in three layers—longitudinal, circular, and oblique.

The *longitudinal fibers* are placed externally and are continuous with the longitudinal fibers of the esophagus. They are thinly distributed over the whole extent of the stomach, but are more abundant along the curvatures and especially along the lesser curvature. They become more numerous near the pyloric end, where they are more evenly distributed and are continuous with the longitudinal muscular fibers of the duodenum.

The *circular fibers* lie immediately beneath the longitudinal set. They are distributed over the whole extent of the organ. At the pyloric end of the stomach they are very abundant, and here form a sphincter which, with the mucous membrane covering its surface, is known as the *pyloric valve*.

The *oblique fibers* are continuous with the circular fibers of the esophagus. They are found principally near the cardiac end of the stomach, where they pass to the left of the esophagus and run obliquely from right to left and from left to right, and finally unite with the circular fibers of the stomach.



THE STOMACH AND ITS ARTERIES.

The **submucous coat of the stomach**, sometimes called the areolar or vascular coat, is composed of loose areolar tissue. It connects the muscular with the mucous coat, and transmits the blood-vessels which run freely through this coat before supplying the mucous layer.

The **mucous coat of the stomach** is quite thick, and presents a smooth, soft internal surface. In a healthy condition it is of a pinkish hue, which is much brighter in the infant. When the stomach is empty and collapsed, the mucous membrane is thrown up into numerous longitudinal folds, or rugæ. These are more numerous along the greater curvature. The *muscularis mucosa*, a thin layer of muscular fibers, is placed in the deeper part of the membrane.

If the internal surface of the mucous membrane be examined microscopically, it will be found to be made up of numerous little hexagonal pits or depressions, which give it a honeycombed appearance. At the bottom of the pits will be seen the minute orifices of the ducts of the gastric glands. A section perpendicular to the surface of the membrane shows under the microscope the glands arranged in parallel lines at a right angle to the surface of the membrane. They terminate above the areolar layer in blind, sacculated ends. These glands secrete the gastric juice. For a description of these glands the student is referred to works on histology.

BLOOD SUPPLY.—The blood supply of the stomach is derived from the gastric, pyloric, right and left gastro-epiploic arteries, and the vasa brevia. These vessels supply the muscular coat and then ramify in the submucous layer, where they break up into small vessels for final distribution to the mucous coat. The **veins** which correspond to the pyloric and gastric arteries terminate in the vena porta; those corresponding to the vasa brevia and the left gastro-epiploic arteries end in the splenic vein; and the right gastro-epiploic vein empties into the superior mesenteric vein.

The **lymphatics of the stomach** follow the blood-vessels of the organ. Some of them follow the vessels along the curvatures between the layers of the omenta, and others pass from the cardiac end with the vasa brevia. They arise in the subserous and submucous coats, and are divided into three sets, which accompany corresponding blood-vessels. One set passes along the lesser curvature with the gastric vessels, collecting from both walls, and turns downward to enter the celiac glands. Another set runs along the greater curvature with the right gastro-epiploic vessels, receiving from both walls; these are joined by lymphatics from the duodenum and also end in the celiac glands. A third set passes from the cardiac end with the vasa brevia, to join the splenic lymphatics.

Surgical anatomy of the stomach.—The portion of the stomach most accessible for operative interference is represented by a triangle bounded on the right

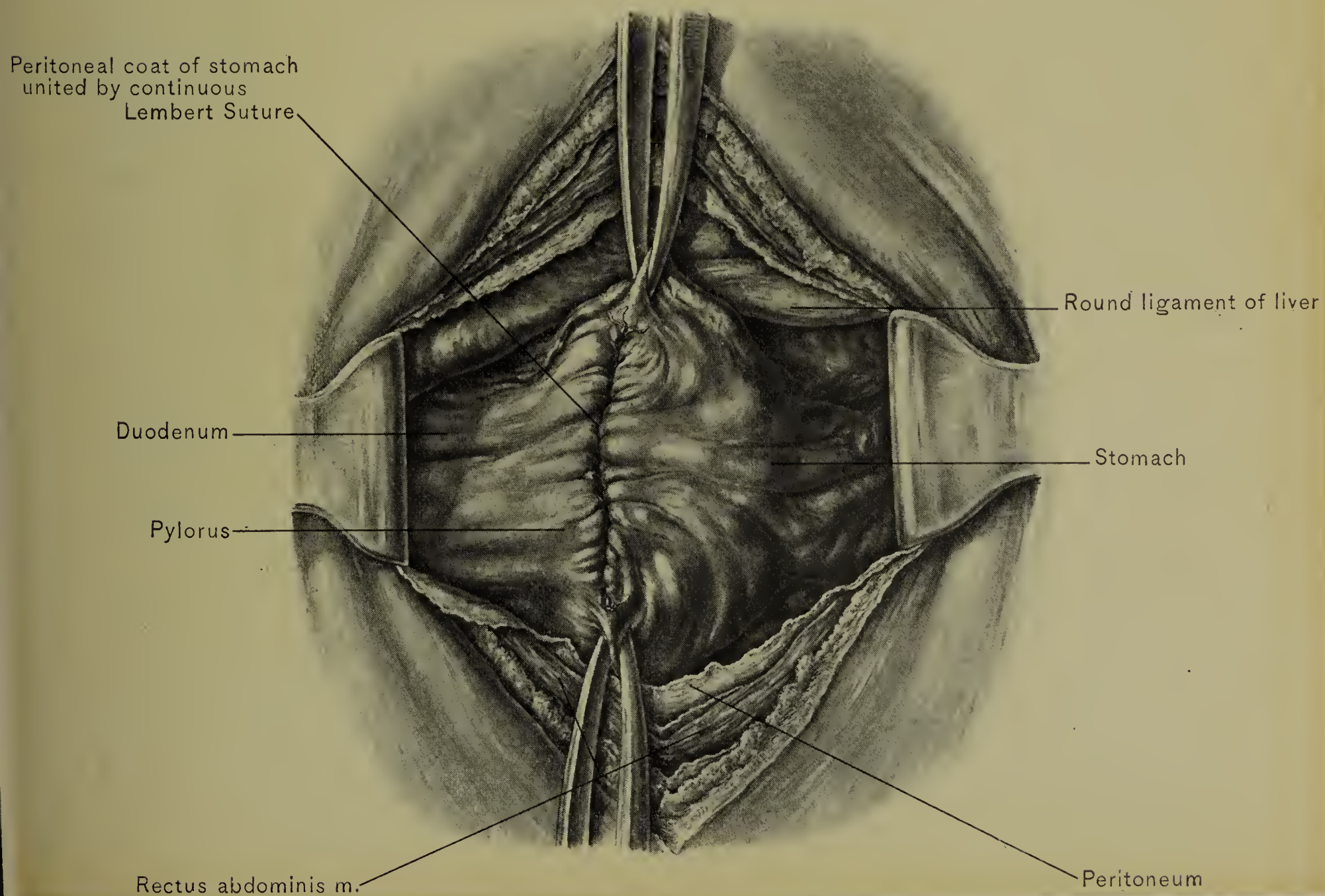
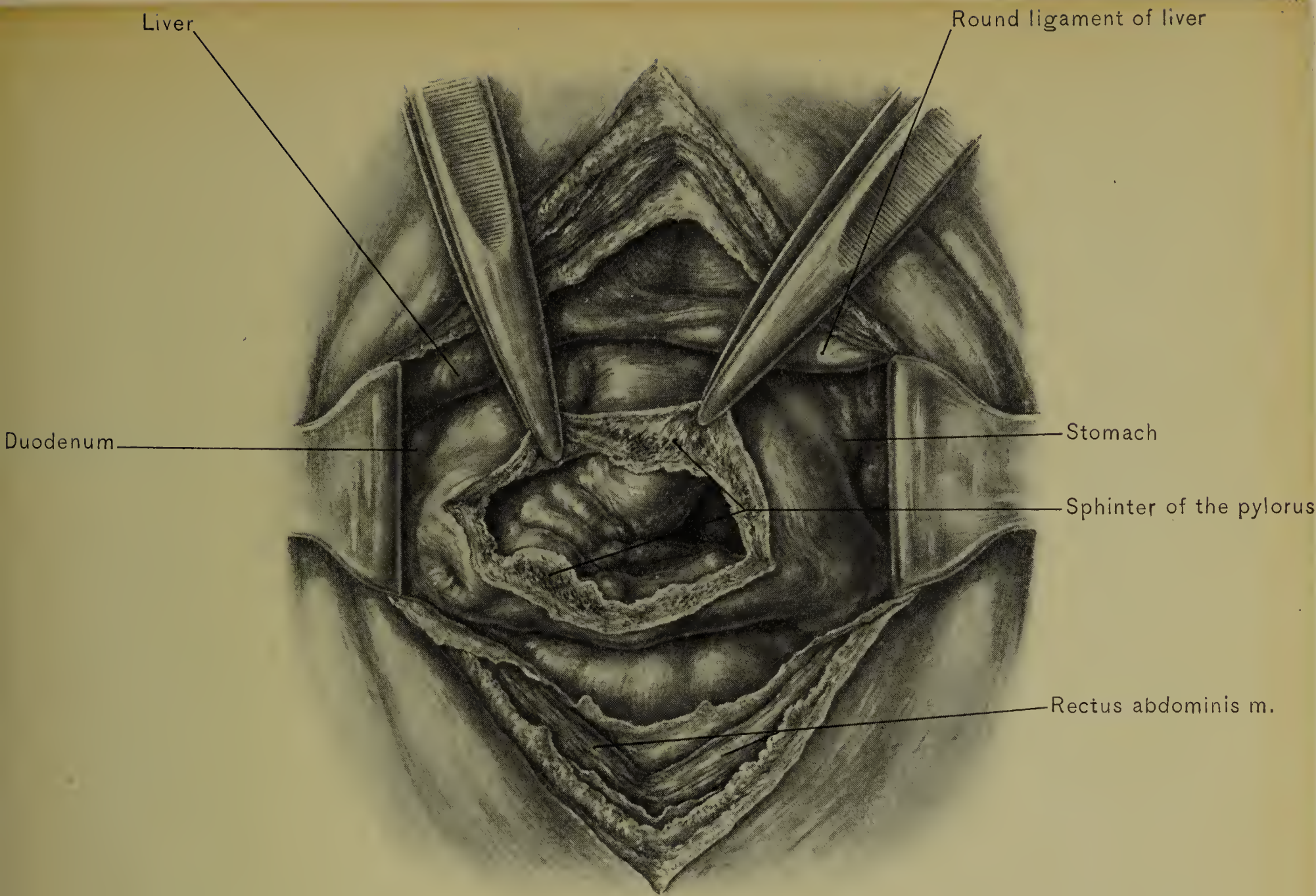
side by the anterior margin of the liver, on the left by the cartilages of the eighth and ninth ribs, and below by a horizontal line passing between the tips of the tenth costal cartilages. The horizontal line corresponds with the lower portion of the stomach when not much distended. To expose the stomach, one of four incisions may be used: parallel with, and about two fingerbreadths from the free border of the left costal cartilages; through the linea alba; or through the left semilunar line; or through the left rectus muscle.

Gastrostomy is the operation performed in establishing an artificial opening in the stomach through the abdominal walls; through this opening the patient may be supplied with nourishment.

The incision should be made parallel with the border of the costal cartilages of the left side, and about two fingerbreadths to the inner side of the same. The middle of the incision should be about on a level with the lower border of the liver. The skin, superficial fascia, deep fascia, and fibers of the external oblique, internal oblique, and transversalis muscles are divided. At times the linea semilunaris will be crossed, and in this case some of the fibers of the left rectus may be divided. The transversalis fascia, preperitoneal fat, and peritoneum are also divided. When the wound is retracted the liver will generally present, and, immediately under this organ, the stomach will be found. The liver can readily be recognized by its firmness, color, and relation to the surrounding organs. The stomach is drawn into the wound, when the operation can be completed in one or two stages. In the first instance the stomach is opened at once, and the edges of the gastric wound are then sutured to the wound in the abdominal wall. In the first stage of the other method the walls of the stomach are sutured to the edges of the opening in the abdominal walls. The second stage of the operation is not performed until adhesions have formed between the stomach and the abdominal parietes, or in about forty-eight hours. The operation of opening of the stomach is a painless one, requiring no anesthetic. A sharp tenotome or the actual cautery should be used for the purpose, and care must be taken to carry the incision entirely through the wall of the organ, as there is a likelihood that the mucosa may be pushed before the knife. A small rubber drainage tube is then inserted into the wound, and a dressing applied.

In another operation, devised by Witzel, a rubber catheter or tube is introduced into a small opening in the anterior wall of the stomach, and from two to two and a half inches (five to six centimeters) of the projecting portion of the catheter buried by folding over it two plaits of the stomach wall. The stomach, after being replaced, is then sutured to the parietal peritoneum, and the abdominal wound closed except at the site of the catheter. This operation is preferred by the author.

Gastrotomy.—In performing gastrotomy, the steps in the operation are the



INCISION AND SUTURED WOUND IN PYLOROPLASTY.

same as those for gastrostomy, with the exception that the stomach is not sutured to the abdominal walls. A similar incision is made, and the same structures are divided. The stomach should be drawn into the wound, and as large an opening made into it as is necessary to accomplish the purpose for which the operation is performed. If done for stenosis of either orifice, the dilators should then be introduced into the wound of the stomach and the constriction dilated.

In closing the gastric wound, the mucous membrane should first be approximated and held together by a continuous suture. The remaining layers of the stomach should then be closed with Lembert's sutures. In making this suture, the needle is introduced through the serous and muscular layers into the submucosa but not through the mucous layer. After passing through the serous and muscular layers into the submucosa, the point of the needle is directed toward the surface and passes through the muscular and serous coats. It is then passed in the same manner through the serous and muscular coats on the other side of the wound, and the edges of the wound are approximated. This will bring two serous surfaces in contact, while the free edges of the wound, with the sutured mucous membrane, are in contact. The abdominal wound should then be closed in the usual manner.

Pyloroplasty.—The incision is similar to that made in gastrostomy, except that it should be on the right side instead of the left; or it may be made through the linea alba, right semilunar line or right rectus muscle. The peritoneum having been divided, the pylorus is sought and drawn into the wound as far as possible. This can not readily be accomplished on account of the bulk of the stomach, and because the duodenum is held in place by the peritoneum. The incision should be made into the pylorus, in the long axis of the stomach, extending into the stomach and into the duodenum; it should be about an inch and a half (four centimeters) in length, and should divide any stricture of the pylorus which may be present. The ends of the wound are then approximated, and the edges apposed in the direction at right angles to that of the incision. The mucous membrane should first be sutured, the sutures passing parallel with the long axis of the stomach. Lembert's sutures should be used in closing the remainder of the wound in the organ, these also being passed in a direction parallel with the long axis of the stomach.

The incision into the pylorus will divide the serous, muscular, submucous, and mucous coats, and some branches of the pyloric and right gastro-epiploic arteries.

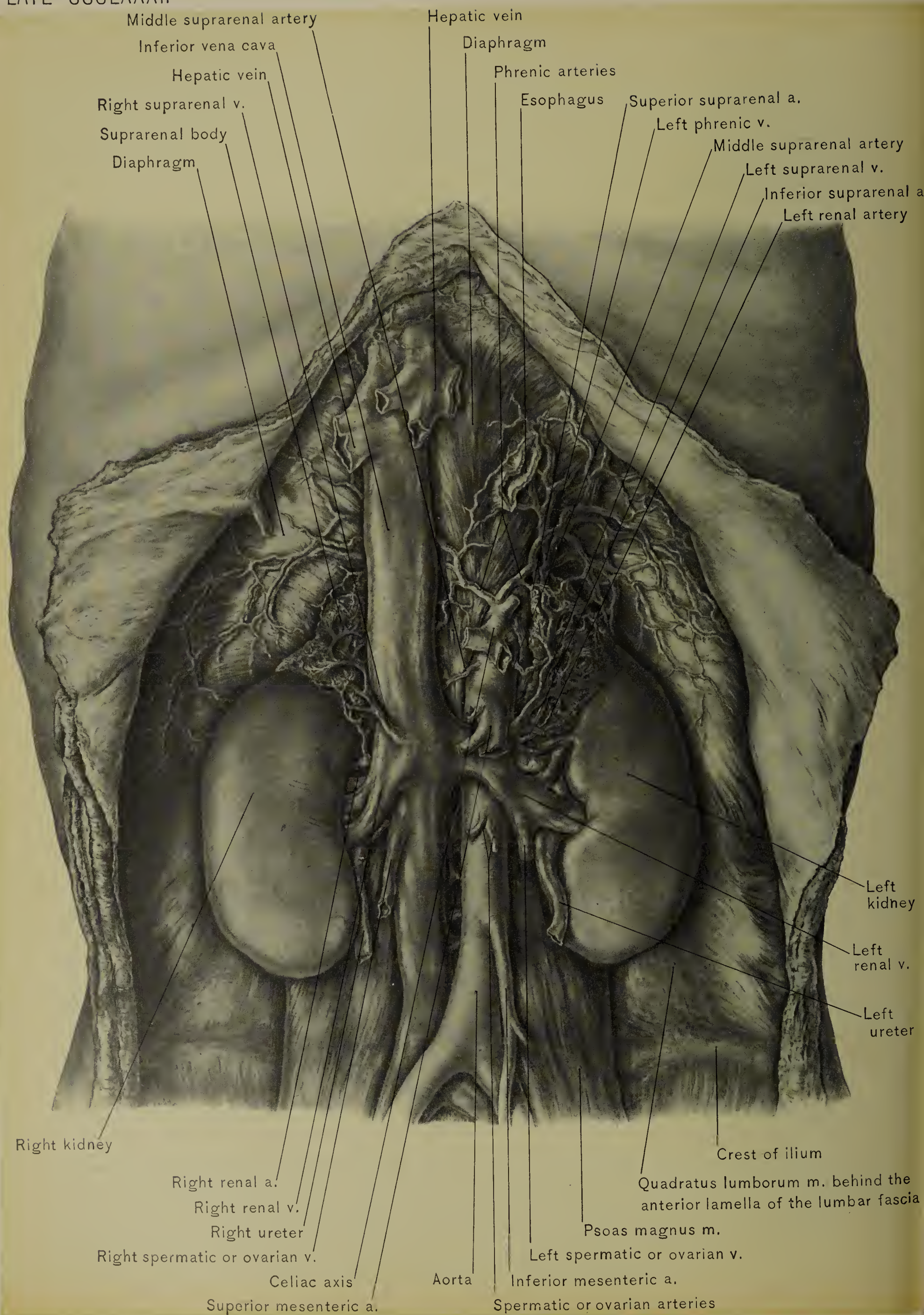
The wound in the abdominal parietes should be closed in the usual manner.

Pylorectomy.—The incision should be made over the mass in the pylorus for the removal of which the operation is performed. If possible, the incision should be made in the linea alba, when the skin, superficial fascia, aponeuroses at the linea alba, transversalis fascia, preperitoneal fat, and peritoneum are divided. The in-

cision may also be made through the right rectus muscle. After the mass has been explored and, if possible, all adhesions separated, it should then be drawn into the wound as far as possible and the portions of the greater and lesser omenta attached to the pyloric end of the stomach should be cut between two sets of ligatures. These omenta should be divided far enough beyond the malignant growth to allow the knife to pass through healthy tissue. The next step in the operation consists of making an oblique incision through the stomach-walls from above downward and from before backward. This should divide about two-thirds of the stomach-wall at the position of incision, the remaining third being allowed to remain intact for the present. The proximal part of the divided stomach should then be closed with a continuous suture for the mucous membrane, and Lembert sutures for the muscular and serous layers. The remainder of the stomach-wall should next be cut in the line of the previous incision into it. After the anterior two-thirds of the wound in the stomach have been closed, the remaining opening into the organ will about equal the lumen of the gut to which it is to be sutured. The duodenum should next be divided far enough from the diseased portion to assure healthy tissue for the sutures. The gut may be divided entirely, or a portion may be allowed to remain by which it may be held in contact with the stomach. The end of the divided duodenum should then be brought in contact with the end of the stomach and held in place by two rows of sutures, one introduced after the manner of Woelfler, the other after Lembert. Woelfler's suture is introduced from within the lumen of the viscera. The needle is passed between the mucous and muscular coats and then through the muscular and serous layers. It is then passed through the serous and muscular layers of the other viscus, and brought out between the mucous and muscular layers. These sutures should be tied firmly. The Lembert sutures may be introduced at this time into this portion of the anastomosis, or the remaining duodenum may be divided in the line of the first incision. Having removed the remainder of the diseased pylorus, the anastomosis should be completed with Woelfler's sutures, and the additional row of Lembert sutures introduced as a reinforcement for the Woelfler's sutures, if they have not been introduced before. The wound in the abdominal parietes is then to be closed in the usual manner. Many prefer the Murphy button.

It will be remembered that the common bile duct and the pancreatic duct enter the duodenum about four inches (ten centimeters) beyond the pylorus. Care must be exercised in the manipulation so that these structures may not be disturbed. The vessels divided during the resection will include the pyloric, the right gastro-epiploic, and usually the gastro-duodenal artery and some of their branches, together with their accompanying veins.

PLATE CCCLXXXI.



ABDOMINAL AORTA, INFERIOR VENA CAVA, KIDNEYS, AND URETERS IN SITU.

Gastro-enterostomy.—The abdominal walls should be incised in the same manner as described under pylorotomy. The same structures will be divided. The great omentum should then be pushed to the left, and a loop of the jejunum, as near the duodenum as practicable, should be brought into the wound. A portion of the anterior surface of the stomach should also be brought into the wound and the two viscera approximated. Many operators prefer to unite the intestine to the posterior wall of the stomach by means of the Murphy button. An incision should be made into the walls of each, the serous and muscular layers being divided, and the submucous and mucous layers being allowed to remain intact for the present. The posterior part of the incised portions should then be approximated and held in place by a series of Woelfler's sutures. The submucous and mucous layers may be divided with a pair of scissors, and the anastomosis completed with Czerny's sutures. The anastomosis should then be reinforced by a row of Lembert sutures, these sutures also approximating the gut and the stomach for about one or two inches (three to five centimeters) beyond the anastomosis, in order to prevent angulation of the gut. This operation can also be done by means of the Murphy button.

Severe bleeding from branches of the gastric, pyloric, gastro-epiploica dextra, and gastro-epiploica sinistra arteries may occur from the incised stomach.

The **Kidneys** are enveloped and supported by a layer of connective tissue which is derived from the parietal portion of extraperitoneal areolar tissue. In some cases the fat in this enveloping membrane will be very abundant; in others the fat is so scanty in quantity that the connective tissue forms a thin, translucent covering which might readily be mistaken for peritoneum or transversalis fascia. It is through lessened intra-abdominal pressure and the laxity of this fat-bearing connective tissue that the kidney is sometimes allowed to move from its normal position; it is then called a movable, floating, or wandering kidney. As this fat is poorly supplied with blood, it is frequently affected by abscess. This is a perinephric abscess, which follows injuries, disease of the kidney, of the spine, of the vermiform appendix, or of some adjacent structure. The pus may follow the extraperitoneal fat downward to the iliac fossa and pelvis; it may empty into the large bowel or the bladder, and may ulcerate through the lumbar fascia and appear at Petit's triangle.

Position.—The right kidney is situated from one-third to three-fourths of an inch (one to two centimeters) lower than the left one on account of the situation of the liver on the right side. Consequently the left kidney extends as high as the upper border of the eleventh rib, although the right reaches only the level of the lower border of that rib. The kidneys are situated one on each side of the great vessels and spinal column, opposite the bodies of the last thoracic and upper two lumbar vertebræ. On the surface their vertical limits are marked by the

upper borders of the tips of the spines of the last thoracic and third lumbar vertebræ, and they extend laterally about three and one-half or four inches (nine to ten centimeters) from the spinous processes of these vertebræ.

As the kidneys are at the side of the lumbar spine, which is freely movable, it is possible for these organs to be squeezed between the ribs and the ilium during extreme forcible flexion of this portion of the vertebral column. This might produce hematuria.

In some instances the kidney can be palpated at the outer border of the erector spinæ muscle, just below the last rib.

DISSECTION.—The kidneys should now be removed from the abdominal cavity by severing the renal and suprarenal vessels, the ureter, and the attachments of the connective-tissue membrane which holds the organ in place. This enveloping tissue should then be removed carefully from the kidney, care being taken to leave the suprarenal body upon the kidney.

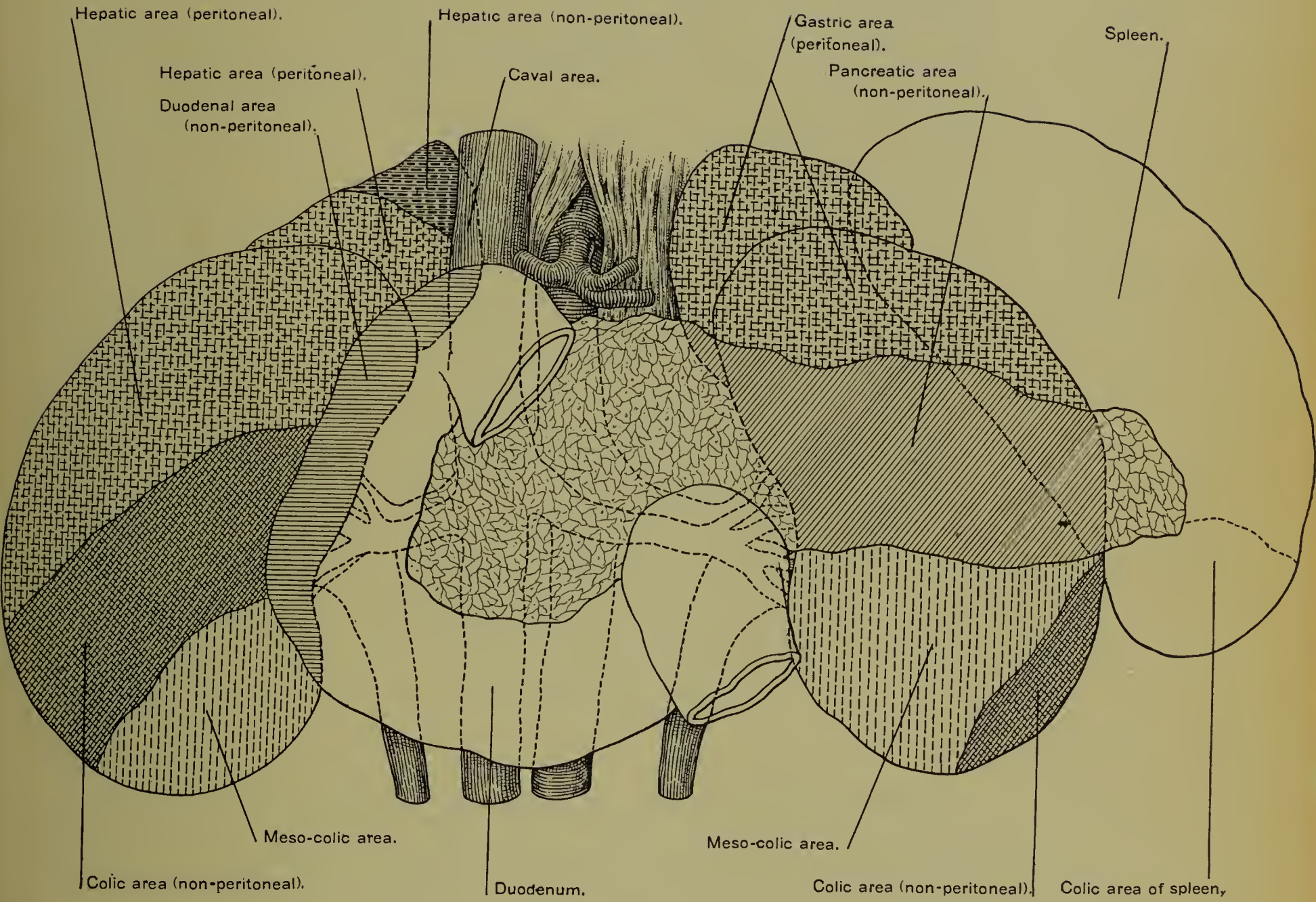
The shape of the kidney is so well known and is so characteristic that the term “kidney shape” is commonly used in descriptive language (Cunningham).

It is surrounded by a dense fibrous covering, the **capsule**. In the healthy organ this capsule can be easily stripped from the glandular substance of the kidney, but in some pathologic conditions the capsule becomes so adherent that it is impossible to remove it without tearing away some of the glandular tissue. The capsule enters the hilum and lines the sinus of the kidney; here it is continuous with the sheaths of the renal vessels and with the external coat of the ureter.

Each kidney weighs from four to five ounces (one hundred and ten to one hundred and forty grams) in the male, and slightly less in the female. It has an anterior and a posterior surface, an upper and a lower extremity, and an external and an internal margin. Its color is reddish brown.

The **anterior surface** is directed forward and outward. This surface of the right kidney is related, from above downward, with the renal impression of the liver, the colon, and the peritoneum; along its mesial margin it is overlapped by the descending duodenum. The hepatic area of this surface is covered by peritoneum, but the colic and duodenal areas are not so covered. In front of the left kidney are, in the same order, the stomach, the splenic vessels, the tail of the pancreas, the peritoneum, and the colon.

The **posterior surface** is directed backward and inward toward the spinal column. The upper third of this surface rests against the diaphragm, the lower two-thirds against the fascia covering the psoas magnus muscle and upon the anterior lamella of the lumbar fascia, which covers the quadratus lumborum muscle. The anterior branch of the last thoracic, the ilio-hypogastric, and the ilio-inguinal nerve pass outward behind the lower half of the kidney.



Apex of papilla with orifices of uriniferous tubules

Attachment of calyx

Margin of hilum

Cortico medullary a.
Vessels

Medulla

Medulla

Malpighian pyramid
Bottom of Sinus

Column of Bertini

Cortex

Malpighian pyramid

Papilla

Bottom of Sinus

Artery

Ureter

Vein

Column of Bertini

Vessels

Medulla

Cortex

SECTIONS OF KIDNEY.

The **extremities** are rounded ; the upper end is thicker and broader than the lower, and is surmounted by the suprarenal capsule.

The **external margin** is convex from above downward and free. The upper portion of this margin of the left kidney is in contact with the renal or inner surface of the spleen, while that portion of the right kidney is in relation with the right lobe of the liver. The **internal margin** is concave and attached to the nerves and vessels of the kidney. These structures enter this margin through a fissure or slit, called the **hilum**, which opens into a chamber called the **sinus of the kidney**. The vessels which pass through the hilum and lie in the sinus are, from before backward : branches of the renal vein, branches of the renal artery, other branches of the renal vein, and the ureter. The upper part of the inner margin of the right kidney is quite near the inferior vena cava, but the lower portion of this margin is some distance from it. The inner margin of the left kidney is two to three centimeters distant from the aorta.

The right and the left kidney may readily be distinguished by the relation of the vessels at the hilum, the ureter being behind the other vessels and bent downward ; the upper end of the kidney is larger than the lower extremity.

Structure of the Kidney.—If the kidney be divided longitudinally through its convex margin to the hilum, it is found to consist of two parts, distinctly visible to the naked eye—an outer cortical layer and an internal medullary layer.

The **outer layer** or **cortex** forms the surface of the kidney. It is about one-fourth of an inch (six millimeters) in thickness, and sends processes inward between the Malpighian pyramids of the medulla. These processes are called the **columns of Bertini**, and carry the blood-vessels from the sinus of the kidney to the line between the cortex and medulla. The cortex contains the more important secreting structures of the organ, while the medulla is composed of conducting tubules. In the cortex are found the **Malpighian bodies** ; these are composed of a tuft of vessels, surrounded by the **capsule of Bowman**, which is the sac-like commencement of the uriniferous tubules.

The **pyramidal** or **medullary substance**, denser in structure than the cortex, is formed by the converging straight conducting tubes which carry the urine from the cortical substance to the central cavity or sinus of the organ. The pyramids are finely striated. The apices of the **medullary pyramids** or **Malpighian pyramids** project into the sinus of the kidney as small mammillary eminences called the **renal papillæ**. These are embraced by a process of the ureter called the **calyx**, and are marked by numerous small openings of the uriniferous tubules (**foramina papillariæ**), from which urine is readily expressed by slight compression. There are generally about a dozen papillæ, but they vary in number from eight to twenty.

BLOOD SUPPLY.—The blood supply of the kidney is derived from the renal artery, which divides into four or five branches that enter the hilum and then subdivide for distribution to the substance of the organ. Sometimes one or more of these primary branches enter the kidney through its cortical substance, perforating the capsule. The artery is very large in proportion to the organ it supplies. The **renal veins** form arches at the bases of the medullary pyramids, whence they accompany the arteries to the sinus of the kidney, uniting external to the hilum to form the renal vein, which empties into the inferior vena cava.

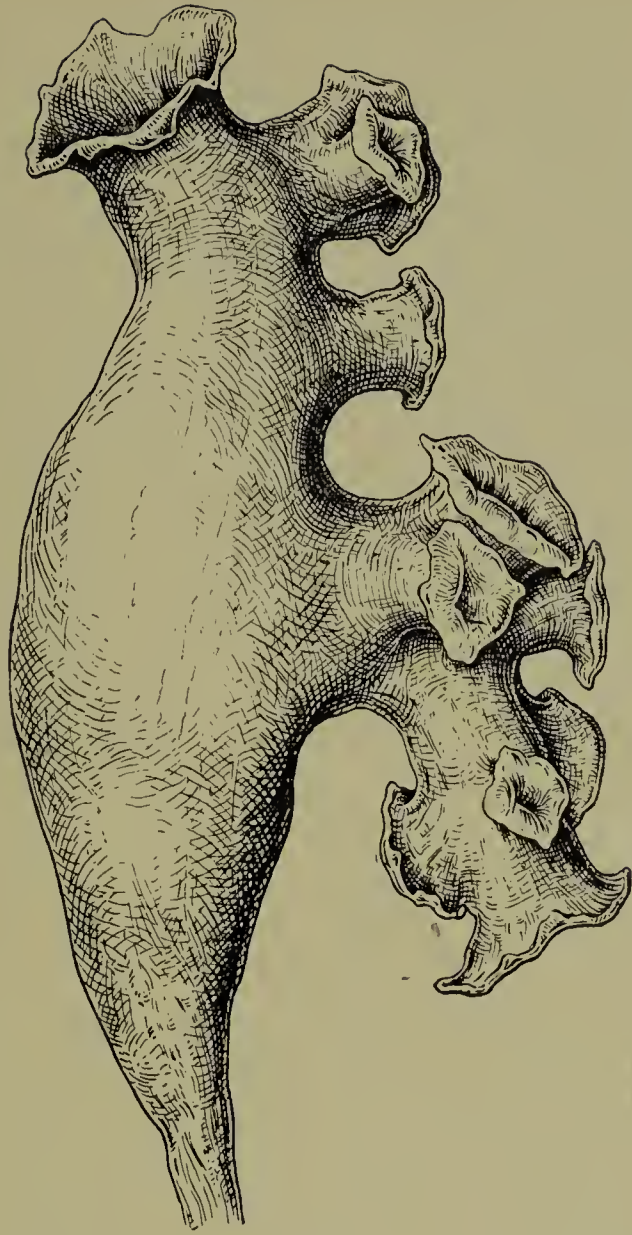
NERVE SUPPLY.—The nerve supply of the kidney is derived from the solar plexus and lesser splanchnic nerves; branches accompany the arteries into the substance of the organ, some filaments also going to the spermatic plexus and ureter.

The **lymphatics** consist of a superficial set, which ramifies over the surface of the organ, and a deep set, accompanying the blood-vessels in the interior of the kidney; they all terminate in the lumbar glands.

The **Ureter** is the excretory duct of the kidney. The upper, expanded, and funnel-shaped portion of the ureter is known as the pelvis. The **pelvis of the ureter** divides within the sinus of the kidney into three branches (*infundibula*), and these again subdivide into the *calices* which embrace the renal papillæ. The ureter proper has the diameter of a goose quill, and is about fourteen inches (thirty-five centimeters) in length. It bends downward and inward from the apex of the pelvis, and continues in this direction, lying in the extraperitoneal fat. It rests upon the psoas magnus muscle as far as the brim of the pelvis, where it passes over the external iliac artery near the bifurcation of the common iliac artery, and enters the pelvis to reach the base of the bladder. The right ureter lies close to the outer side of the inferior vena cava, and is covered by the ileum as it enters the pelvis. The left ureter is covered by the sigmoid flexure at its lower abdominal portion. Both ureters are crossed obliquely in front by the spermatic vessels.

The ureters have three coats—viz., a fibrous, a muscular, and a mucous. The **fibrous coat** is continuous above with the true capsule of the kidney, and below with the wall of the bladder. The **muscular coat** is composed of an outer circular and an inner longitudinal layer. In its lower portion there is an additional thin external longitudinal layer of muscle-fibers. The **mucous membrane** presents longitudinal folds and is lined with transitional epithelium. The ureter may be greatly distended by a stone, and if the ureter be ruptured, urine collects in the subperitoneal fat and leads to the formation of an abscess.

BLOOD SUPPLY.—The blood supply of the ureters is derived from the renal, spermatic, internal iliac, and vesical arteries. The **veins** empty into corresponding trunks.



TYPES OF SINUS OF KIDNEY.

NERVE SUPPLY.—The nerve supply of the ureter is derived from the inferior mesenteric, spermatic, and hypogastric plexuses of nerves.

When a renal calculus passes down the ureter, it gives rise to pain in the course of that tube and in the testicle, referred there by the spermatic plexus of nerves, and in the thigh through branches of the lumbar plexus.

Obstruction of a ureter dams the urine in the pelvis of the ureter and the kidney, producing *hydronephrosis*, or distention of the kidney with urine.

A **movable kidney** is one which is so loosely attached that it shifts its position back of the peritoneum. In some cases the fatty capsule is so large and so loosely connected with the kidney that the organ has room for movement within the capsule. In others the tissue surrounding the kidney is so loosely attached to the peritoneum and posterior abdominal walls that the whole mass is free to move. The extent of the movement in this instance is limited by the attachment of the vessels. A **floating kidney**, on the other hand, is one which has a complete peritoneal investment, with a mesentery or meso-nephron sufficiently long to permit its free movement about the abdomen. A movable kidney often produces discomfort and may be very painful, sometimes being so distressing as to necessitate an operation for anchoring it to its normal position—*nephrorrhaphy*. In anchoring a floating kidney, it must be remembered that the vessels may be shortened on account of the congenital position of the kidney, and that much traction upon them, especially on the vein, may interfere with the circulation and cause the kidney to undergo serious change. Movable kidney occurs more frequently in women, and commonly upon the right side.

Nephrectomy.—The kidney may be removed by an incision through the lumbar region, or by one through the linea semilunaris, or through the rectus muscle. In the lumbar operation the incision is made between the last rib and the crest of the ilium. The tissues divided are the skin, the superficial and deep fasciæ, the anterior fibers of the latissimus dorsi muscle, the posterior part of the external and internal oblique and transversalis muscles, and the transversalis and lumbar fasciæ. The anterior branch of the last thoracic nerve may be found lying in the wound anterior to the lumbar fascia. This should be pushed aside and not cut, if it can be avoided. After dividing the lumbar fascia, the perirenal fat usually bulges into the wound. This should be torn and the external margin of the kidney sought for. If the perirenal fat is abundant, some of it should be ligated and removed, as its blood supply is so poor that it may subsequently cause trouble by breaking down. The kidney should be freed from its surrounding perirenal fat in order to reach the vessels and duct. The ureter should be tied, and the vessels then ligated. The pedicle may be severed with a pair of scissors, and the kidney removed. Care must be taken that too much traction is not made on

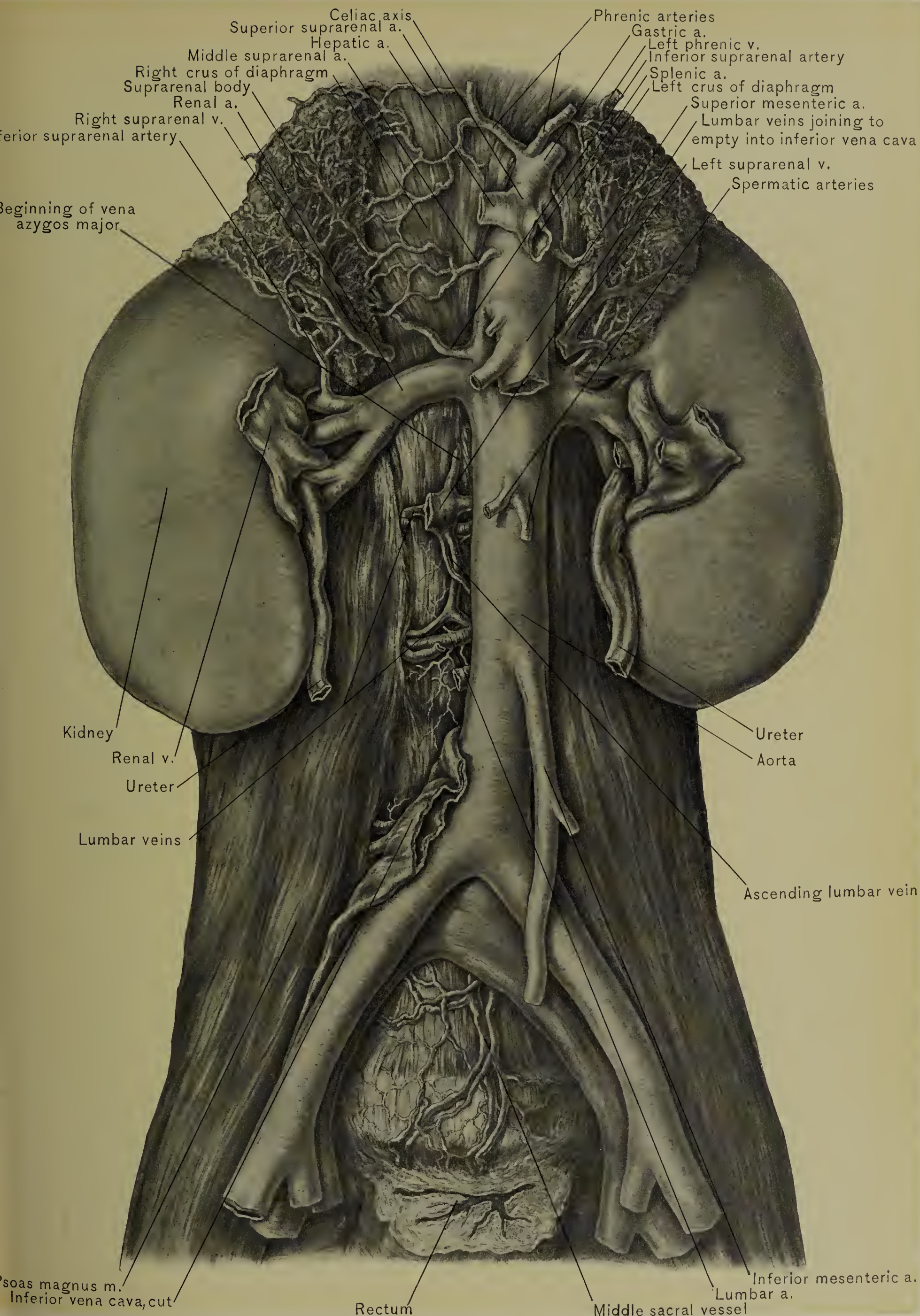
the kidney, as there is danger of tearing the vessels, especially the vein. It must also be remembered that the vein on the right side is very short, and that there is danger of tying a part of the inferior vena cava in the ligature. By prolonging the incision downward, the ureter may be explored, and, if necessary, removed extraperitoneally.

In the intra-abdominal operation the incision is made on a level with the umbilicus, in the line of the linea semilunaris, or, preferably, to the inner side of the linea semilunaris, the fibers of the rectus muscle being separated. The structures divided at the linea semilunaris are the skin and superficial fascia, the aponeuroses at the outer edge of the rectus muscle, the transversalis fascia, preperitoneal fat, and peritoneum. To the inner side of the linea semilunaris the skin, superficial fascia, anterior wall of the rectus sheath, rectus muscle, posterior wall of the rectus sheath, transversalis fascia, preperitoneal fat, and peritoneum are divided. The intestine should then be held to one side, and the colon with its meso-colon be brought into view. The outer layer of the meso-colon should then be opened. The tissue around the kidney should be broken through, the pedicle ligated as in the lumbar operation, and the kidney removed. It is advisable not to open the capsule of the kidney, as the danger of septic infection would be greatly increased if this were done. The incision is made through the external layer of the meso-colon because it contains but few vessels, whereas the large vessels to the colon pass behind the internal layer.

The kidney may also be removed through the linea alba, but this is not so safe a method as that of removing it through the linea semilunaris, because in the median line one is further away from the kidney, a greater expanse of peritoneum is exposed, and it is necessary to cut through the internal layer of the meso-colon to reach the kidney. Jacobson has reported a case in which he made an incision from the anterior superior spine of the ilium to the eighth rib, through the abdominal walls, and then stripped the peritoneum from the walls of the iliac fossa, reaching the kidney by going postperitoneally.

The other operations performed upon the kidney are nephrotomy and nephrolithotomy. These are done preferably through the loin incision, and are, therefore, extraperitoneal operations.

The **Suprarenal Bodies** or **Capsules** weigh from one to two drams (thirty to sixty grams) each, are of a yellowish color, and surmount the kidneys, closely fitting upon their upper ends. The right capsule is pyramidal, and the left semilunar, in shape. They are sometimes overlooked by the careless or inexperienced, who mistake them for parts of the adjacent extraperitoneal fat. They belong to the group of ductless glands, such as the spleen, thymus, and thyroid. They both rest upon the inner portion of the upper end of the kidney. The right



KIDNEY, RENAL VESSELS, AND URETERS.

suprarenal body is covered anteriorly by the posterior surface of the liver, the peritoneum, and the duodenum, and the left by the peritoneum, stomach, pancreas, and splenic vessels. Behind, each rests upon its respective crus of the diaphragm, opposite the tenth intercostal space or eleventh rib. Mesially they are in relation with the great splanchnic nerve and the semilunar ganglion, the right resting against the inferior vena cava and the left against the aorta. The left suprarenal body is in relation, externally, with the renal surface of the spleen.

On section, the suprarenal capsule is seen to consist of a yellow cortical and a dark-brown medullary substance, the latter sometimes being broken down and leaving a narrow cavity.

BLOOD SUPPLY.—The blood supply of the suprarenal bodies is derived from the suprarenal arteries and from branches of the **phrenic and renal arteries**. These branches subdivide into many minute vessels before entering the organ. Its **vein**, the **suprarenal**, is formed from the **medullary venous plexus** and branches from the cortical substance; the right vein enters the inferior vena cava, and the left, the renal vein. Its **lymphatics** enter the lumbar glands.

NERVE SUPPLY.—The nerve supply of the suprarenal capsule is very liberal, and is derived from branches of the solar and renal plexuses and from the phrenic and pneumogastric nerves. The vessels and nerves enter through a deep fissure called the hilum.

The **Abdominal Aorta** is the continuation of the thoracic aorta, and is about five inches (twelve centimeters) long. It begins at the aortic opening in the diaphragm, opposite the lower border of the body of the twelfth thoracic vertebra. It extends downward upon the left side of the front of the bodies of the lumbar vertebræ to the middle of the body of the fourth lumbar vertebra, opposite which it divides into the right and left common iliac arteries. This point is about three-fourths of an inch (two centimeters) below the level and to the left of the umbilicus, and is located in a line drawn between the highest points of the iliac crests. Just above and to the left of the umbilicus it is readily felt pulsating, and is easily compressed through thin abdominal walls, because it rests here upon the third lumbar vertebra, which is the most anterior portion of the lumbar curve of the spinal column. The aorta tapers off rapidly as it descends, in consequence of its giving off large branches.

RELATIONS.—It is related, behind, with the four upper lumbar vertebræ and the intervertebral discs, from which it is separated by the anterior common ligament, the left lumbar veins, the lower end of the thoracic duct, the receptaculum chyli, and the origin of the left crus of the diaphragm. In front of it are the liver, the lesser omentum, the stomach, the posterior parietal peritoneum, the pancreas, the transverse duodenum, the celiac axis and its branches, the solar plexus,

the aortic plexus, the splenic vein, the left renal vein, and the mesentery. On the right side of it are the right crus of the diaphragm, the vena azygos major, the thoracic duct, the right semilunar ganglion, the right great splanchnic nerve, and the inferior vena cava. On the left side of it are the left great splanchnic nerve, the left semilunar ganglion, the left crus of the diaphragm, the psoas magnus muscle, the tail of the pancreas, and the left kidney.

The **branches of the abdominal aorta** are the phrenic artery, the celiac axis, the superior mesenteric, the suprarenal, the renal, the spermatic or ovarian, the inferior mesenteric, the lumbar, and the sacra media arteries. Its terminal branches are the right and left common iliac arteries.

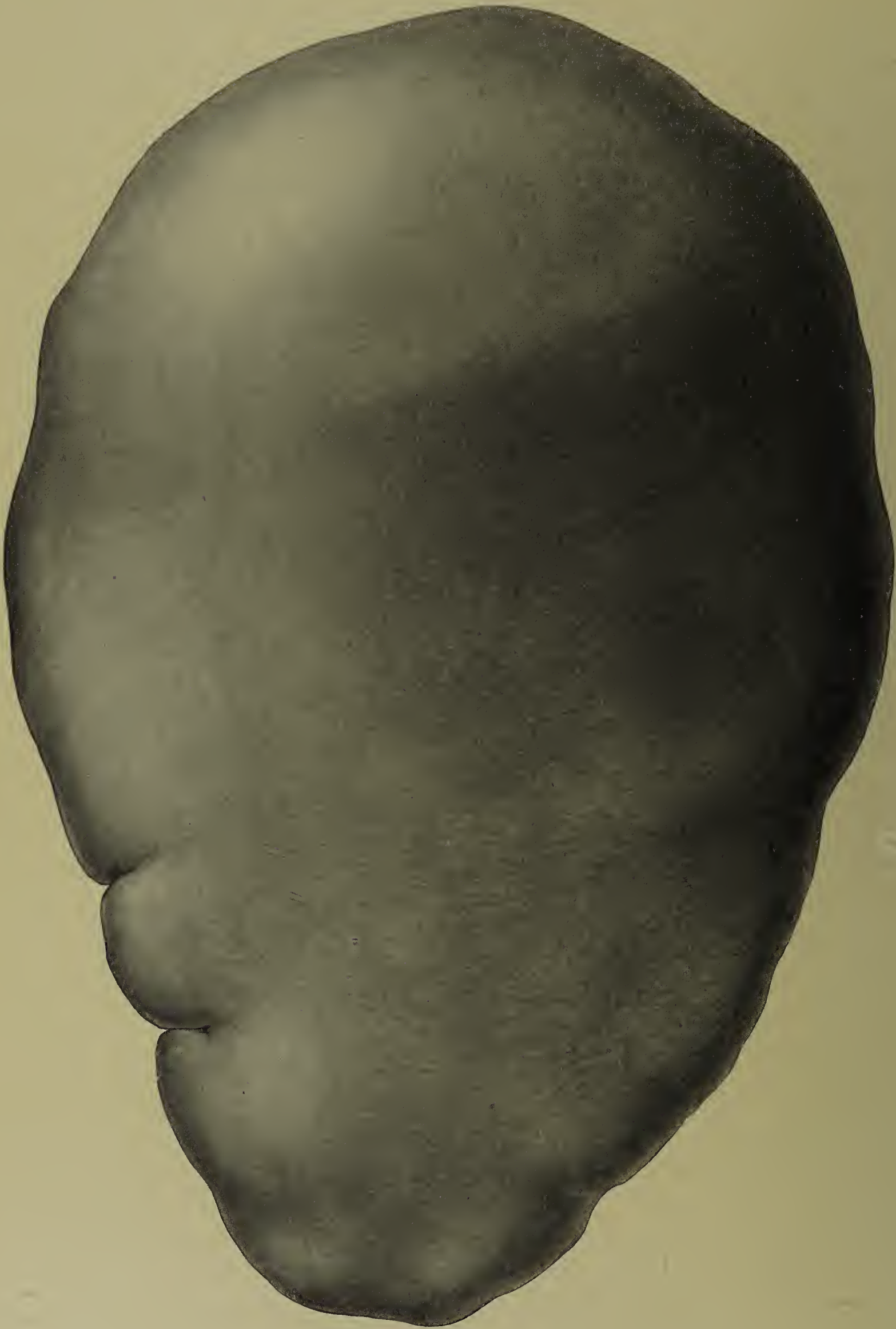
The **phrenic arteries**—inferior phrenic, in contradistinction to the phrenic branches of the internal mammary artery—are two slender vessels which arise very irregularly from the abdominal aorta, either above or below the celiac axis, or from the latter or its branches. They arise separately or by a common trunk. They diverge over the crura of the diaphragm. The left passes behind the esophagus and forward along the left side of the esophageal opening; the right passes over the back of the liver and the inferior vena cava and to the right side of the caval opening. Each divides into an inner and an outer branch. The *inner branch* passes forward to supply the diaphragm, and anastomoses with the phrenic artery of the opposite side and with the musculo-phrenic artery. The *outer branch* runs to the side of the chest, where it anastomoses with the intercostal arteries. The inner branch of the right also supplies the inferior vena cava, the liver, and the right suprarenal body, while that of the left also sends twigs to the left suprarenal body and the spleen.

The **celiac axis** is a short, thick trunk which arises from the front of the aorta immediately below the aortic opening in the diaphragm. It is about an inch (two and one-half centimeters) or less in length, and divides into the gastric, hepatic, and splenic arteries. It lies behind the lesser omentum and the ascending layer of the posterior parietal peritoneum. Upon its right side are the right semilunar ganglion and the lobus Spigelii, and upon its left side are the left semilunar ganglion and cardiac end of the stomach. Above it are the diaphragm and the origins of the phrenic arteries. Below it is the pancreas.

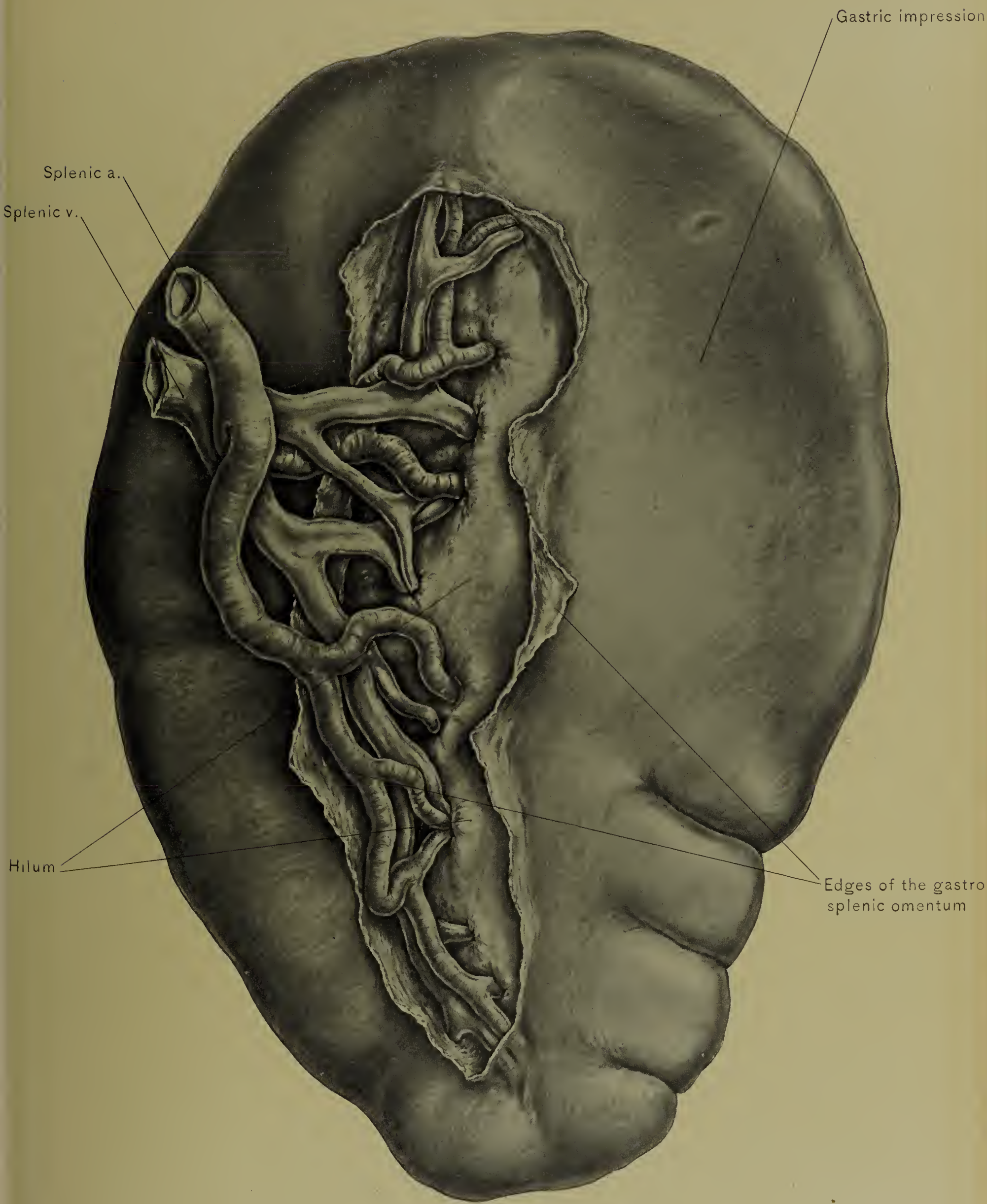
The **gastric artery**, the smallest branch of the celiac axis, passes upward and to the left behind the ascending layer of the posterior parietal peritoneum, to the cardiac end of the lesser curvature of the stomach. Here it gives off *esophageal branches* which pass upward to anastomose with esophageal branches from the thoracic aorta, a *hepatic branch* which passes upward and to the right between the layers of the lesser omentum to reach the liver, and *cardiac branches* to the cardiac end of the stomach, which join branches of the splenic artery. It then turns down-



STOMACH, LIVER, PANCREAS, CELIAC AXIS, HEPATIC, PYLORIC, AND GASTRIC ARTERIES, AND PORTAL VEIN.



THE EXTERNAL SURFACE OF THE SPLEEN.



THE INTERNAL SURFACE OF THE SPLEEN.

ward and to the left along the lesser curvature of the stomach, supplying gastric branches to both walls of the stomach. This portion of the vessel, often called the coronary artery, runs between the two layers of the gastro-hepatic omentum and anastomoses with the pyloric branch of the hepatic artery on the lesser curvature of the stomach.

The **hepatic artery**, intermediate in size between the gastric and splenic arteries, extends upward and to the right along and above the head of the pancreas, where it gives off *pancreatic branches*. It then passes between the two layers of the gastro-hepatic omentum. In this omentum it gives off the small *pyloric branch* opposite the pylorus, to join the gastric, as previously stated, the *gastro-duodenal branch*, which supplies the stomach, duodenum, and pancreas, and the *cystic branch* to the gall-bladder. Near the transverse fissure of the liver it divides into a right and a left branch for distribution to the respective lobes of the liver. The *pancreatic branches* supply the pancreas. The *gastro-duodenal* artery passes downward behind the first portion of the duodenum to the lower border of the stomach, where it gives off a few *inferior pyloric arteries*, and divides into the gastro-epiploica dextra and the pancreatico-duodenalis superior.

The **gastro-epiploica dextra artery** passes from right to left along the greater curvature of the stomach, between the anterior layers of the great omentum, sending branches to both walls of the stomach and to the great omentum. It anastomoses with the gastro-epiploica sinistra artery, a branch of the splenic.

The **superior pancreatico-duodenal artery** passes downward between the adjacent surfaces of the duodenum and pancreas to supply them, and to anastomose with the inferior pancreatico-duodenal branch of the superior mesenteric artery.

The **splenic artery** is the largest division of the celiac axis, and is remarkably tortuous. It passes from right to left along the upper margin of the pancreas in company with and above the splenic vein, giving off descending small pancreatic branches (*pancreaticæ parvæ*) to the substance of this gland. The largest one of these, near its left end, accompanies the pancreatic duct from left to right, and is called the *pancreatica magna*. Near its termination the splenic artery gives off the gastro-epiploica sinistra.

The **gastro-epiploica sinistra artery** first descends between the two layers of the gastro-splenic omentum, and then passes along the greater curvature of the stomach from left to right, between the two layers of the great omentum, to join the gastro-epiploica dextra. On its way it distributes gastric and omental branches. Beyond the gastro-epiploica sinistra the splenic artery or its terminal branches give off about five or six small vessels (*vasa brevia*) which pass between the layers of the gastro-splenic omentum to the stomach to supply the cardiac end

of that organ. It then breaks up into several branches which enter the spleen at its hilum.

The **superior mesenteric artery** arises from the abdominal aorta behind the pancreas. It passes between the pancreas and the transverse portion of the duodenum; then downward across that part of the duodenum, and enters the mesentery. It finally runs between the two layers of the mesentery at its root, and terminates in the right iliac fossa. It gives off from its convex side from twelve to fifteen *vasa intestini tenuis*, which supply the jejunum and ileum. The first branch from its concave side is the slender *inferior pancreatico-duodenal artery*, which passes between the pancreas and the transverse part of the duodenum, to anastomose with the superior pancreatico-duodenal artery. The other branches of the superior mesenteric artery arise from its concave side, and are the *colica media*, the *colica dextra*, and the *ileo-colic*. These arteries have already been described.

The **suprarenal** or **middle suprarenal arteries** arise from the sides of the aorta at about the level of the superior mesenteric artery, and pass upward and outward to the suprarenal bodies. The **superior suprarenal arteries** are branches of the phrenic arteries, and the **inferior suprarenal arteries** are derived from the renal arteries.

The **renal arteries** arise from the sides of the aorta at a right angle. The right renal artery is longer than the left, because of the location of the aorta to the left of the median line, and is lower than the left, because of the lower position of the right kidney. These vessels subdivide into several branches before entering the hilum of the kidney, the vein being in front of them and the ureter behind them. The right renal artery is crossed in front by the inferior vena cava. Supernumerary renal arteries are quite frequent, a fact to be borne in mind in the operation of nephrectomy.

The **spermatic** or **ovarian arteries**, slender and long, arise from the front of the aorta a short distance below the renals, and pass downward and slightly outward obliquely across the psoas magnus muscle and the ureter to the external iliac artery. From this point the spermatic artery continues, in the *male*, through the internal abdominal ring and the inguinal canal as a constituent of the spermatic cord, for final distribution to the testicle. In the *female* the ovarian artery, which is the homologue of the spermatic artery, passes between the two layers of the broad ligament to supply the ovary. The terminal portion of this artery will be more fully described in describing the pelvis. The right spermatic artery crosses the inferior vena cava obliquely, and the left runs beneath the sigmoid flexure.

The **branches of the spermatic artery** are: The *uretal*, running to the ureter; the *cremasteric*, small branches which supply the cremaster muscle; the *epidi-*

dymal, to the epididymis; and the *testicular*, or terminal, branches. The **branches of the ovarian artery** are the *uretal*, the *Fallopian*, the *uterine*, and the *ligamentous*; they will be described with the pelvis.

The **inferior mesenteric artery** arises from the left side of the front of the aorta, about one and a half inches (four centimeters) above its bifurcation. It is smaller than the superior mesenteric artery. It descends toward the left iliac fossa, giving off the *colica sinistra* and the *sigmoid* arteries, after which it continues into the pelvis to the lower end of the sigmoid flexure as the **superior hemorrhoidal artery**, which is described in the consideration of the pelvic viscera.

The **lumbar arteries**, four on each side, are arranged in a manner similar to the arrangement of the intercostals. They pass outward from the posterior surface of the aorta almost at right angles, and then go backward and outward around the sides of the bodies of the respective vertebræ. They are covered by the *psoas magnus* muscle and the sympathetic nerve. The upper two are also covered by the crura of the diaphragm, and the arteries on the right side are likewise covered by the inferior vena cava. Between the transverse processes of the vertebræ each lumbar artery divides into a dorsal and an abdominal branch. The *dorsal branch* gives off a spinal branch to the interior of the spinal canal, and continues backward to supply the muscles and skin of the lumbar region. It anastomoses with the posterior branches of the adjacent lumbar and intercostal arteries. The spinal branches of the dorsal branches enter the spinal canal upon the lumbar nerves, through the intervertebral foramina. Each divides into an upper and a lower branch, each division joining similar adjoining branches above and below, thus forming lateral arches upon the back of the bodies of the vertebræ. Twigs from these arches join the middle longitudinal (anterior spinal) artery. All these supply the adjacent bone and contents of the spinal canal. The *abdominal branches* of the lumbar arteries run outward behind the *quadratus lumborum* muscle, and thence forward between the abdominal muscles to supply the abdominal wall. The lowest branch sometimes passes in front of the *quadratus lumborum* muscle. These arteries anastomose in front with the epigastric and internal mammary arteries; above, with the intercostals; and below, with the ilio-lumbar and circumflex iliac arteries.

The **middle sacral artery** arises from the posterior surface of the aorta at its point of bifurcation, and goes downward upon the front of the body of the last lumbar vertebra over the sacral promontory, and down the middle of the sacrum to the base of the coccyx, where it inosculates with the lateral sacral arteries. It continues as a small twig down the coccyx

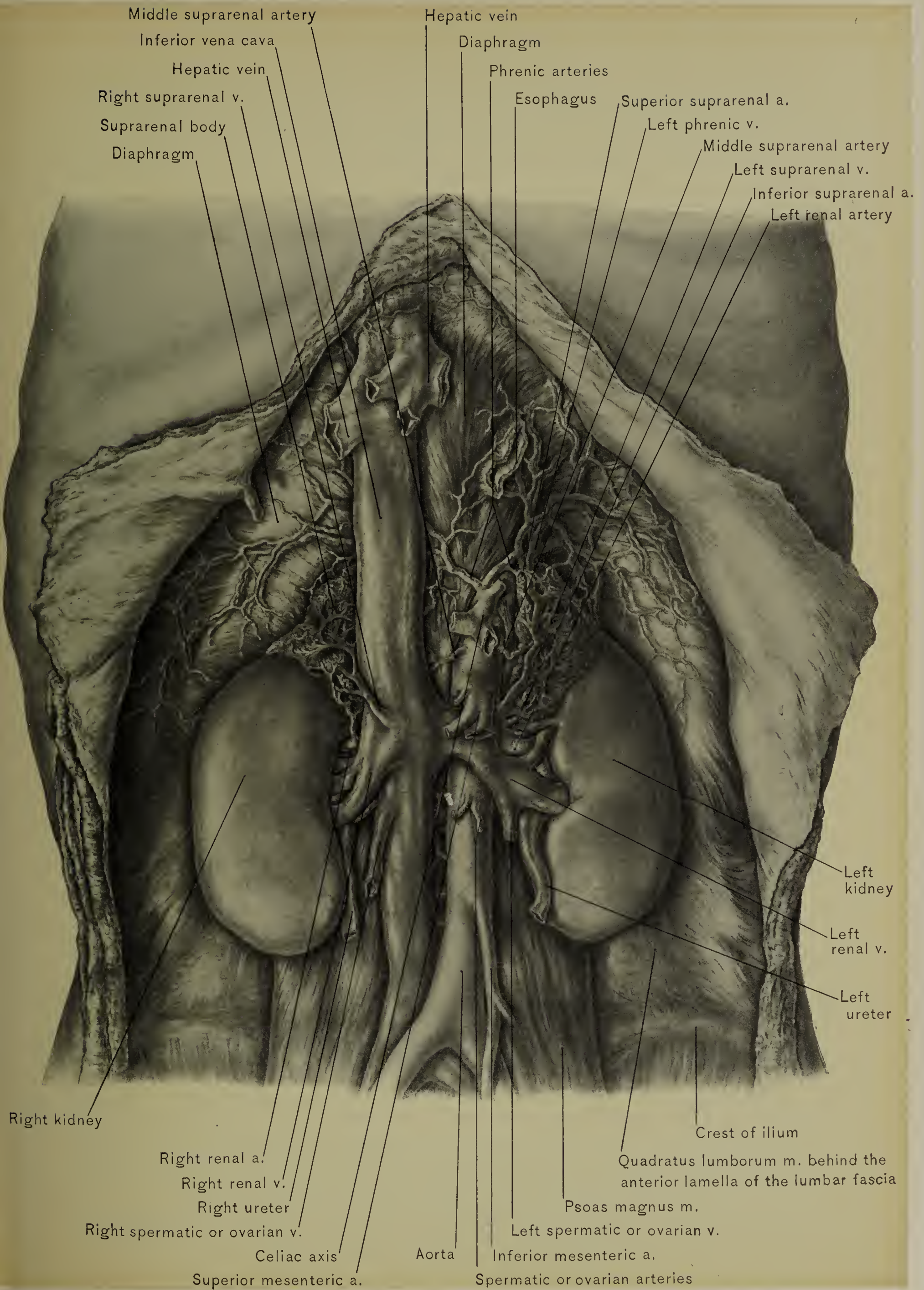
to Luschka's gland, which will be referred to again in the description of the pelvis.

Aneurysm of the abdominal aorta occurs most frequently at the celiac axis, which seems to be the weakest part, for here also is rupture most likely to occur in forcibly injecting coloring material into the arterial system of the cadaver. Tumors of the pancreas and stomach may be mistaken for aneurysm of the abdominal aorta. Aneurysm is often accompanied by backache which is sometimes mistaken for lumbago. By reflex sympathetic disturbance it may cause nausea and emesis. Its constant pressure at times causes gradual absorption of the bodies of the vertebræ, and its pressure upon the spinal nerves may give rise to neuralgia in corresponding areas of nerve distribution. This is true of all intra-abdominal growths which cause pressure upon nerves. It may compress various veins, arteries, or viscera, giving rise to a symptomatology which it is well the student figure out for himself. Thus, he may suppose the extension of the growth in a given direction, estimate its interference with other structures, and deduce the logical symptomatic results. As a general rule, symptoms referred to the back predominate in aneurysms which begin at the back of the aorta, and in those which begin in the anterior wall of this vessel, visceral symptoms are most prevalent.

Ligation of the abdominal aorta is effected through the linea alba, by dividing both the anterior and the posterior parietal peritoneum, or it is done without entering the peritoneal cavity, as in ligation of the common iliac artery.

Compression of the aorta is most readily effected just above and to the left of the umbilicus, where it is nearest to the belly-wall, because the forward lumbar curve of the spinal column is most prominent at that level. This is an infallible method of arresting severe hemorrhage from the pelvis and lower abdomen until other means can be adopted. The heel of the palm or the thenar or hypothenar eminences serve well for this purpose and are always available.

The **Inferior Vena Cava** collects the blood from the lower extremities and the trunk below the diaphragm, except that from the alimentary tract, pancreas, and spleen, which passes through the liver by the portal vein and its tributaries. It is the largest venous trunk in the body, and is formed by the union of the two common iliac veins in front of the right side of the body of the fifth lumbar vertebra. In its ascent it lies upon the bodies of the lower three lumbar vertebræ, the right lumbar and renal arteries, and the right crus of the diaphragm, by which it is separated from the aorta. It passes through the caval opening of the diaphragm and immediately enters the right auricle of the heart. In its upward course it receives the lumbar, the right spermatic or ovarian, the renal, the right phrenic, the right suprarenal, and the hepatic veins. To the left of it lies the



ABDOMINAL AORTA, INFERIOR VENA CAVA, KIDNEYS AND URETERS IN SITU.

aorta, from which it is separated above by the right crus of the diaphragm. In front of it are the mesentery, the right spermatic artery, the transverse duodenum, the pancreas, the portal vein, the hepatic artery, and the liver, which partly encircles it.

The veins tributary to the inferior vena cava generally follow the same course as the corresponding arteries. Because of the position of the inferior vena cava to the right of the median line, the veins entering it from the left are longer than those from the right side; and as the aorta is on the left side of the median line, the arteries arising from the right side are longer than those from the left.

The inferior vena cava sometimes lies upon the left of the aorta, and crosses to the right above the level of the renal veins. In complete transposition of the viscera it lies upon the left side of the aorta throughout its course. Sometimes the inferior vena cava empties into the vena azygos major, which is then necessarily enormously enlarged. The superior vena cava then receives the blood from the entire body, except the territory of the portal vein, the blood from which, after passing through the liver, goes directly to the right auricle by way of the hepatic veins.

The **lumbar veins**, four in number on each side, are found in company with the corresponding arteries. They receive blood through the dorsal tributaries from the muscles and integument of the loins, through abdominal tributaries from the abdominal walls, and through spinal tributaries from the spinal plexuses of veins. In front of the transverse processes of the vertebræ the veins are joined by cross veins which form a continuous vessel, the *ascending lumbar vein*, which is connected by its upper extremity to the vena azygos major on the right side, and to the vena azygos minor on the left side. The lumbar veins empty into the inferior vena cava, those of the left side passing behind the aorta.

The **two spermatic or ovarian veins** differ in their mode of termination; the right enters the inferior vena cava at an acute angle, and the left joins the left renal vein at almost a right angle. This is commonly held to account for the greater frequency of varicocele on the left side, because of the entrance of the spermatic current at right angles to the renal blood current. Other reasons given for this occurrence are that, as the left vein passes under the sigmoid flexure, it is subject to pressure by fecal accumulations in that portion of the bowel; and that, as the left testicle is situated lower than the right, the left spermatic vein is the longer; therefore the column of blood is heavier in this vein.

The **renal veins** lie in front of the renal arteries, thus being an exception to the general rule that the veins of the abdomen lie behind or on the same plane as the arteries. They differ in length, the right being the shorter, a fact to be remem-

bered in the operation of nephrectomy on the right side, for if too much traction be made upon the vein when applying the ligature, there is danger of tying off a part of the inferior vena cava. The left vein receives the left spermatic or ovarian, suprarenal, and phrenic veins, while the right does not.

The **suprarenal veins** differ in their terminations: the right joins the inferior vena cava, and the left empties into the left renal vein, or the left phrenic vein.

The **phrenic veins** also differ: the right phrenic vein enters the inferior vena cava, and the left, the left renal vein.

The **hepatic veins** enter the inferior vena cava directly from the liver, where it hugs this great venous trunk; so that these veins do not exist outside of the liver.

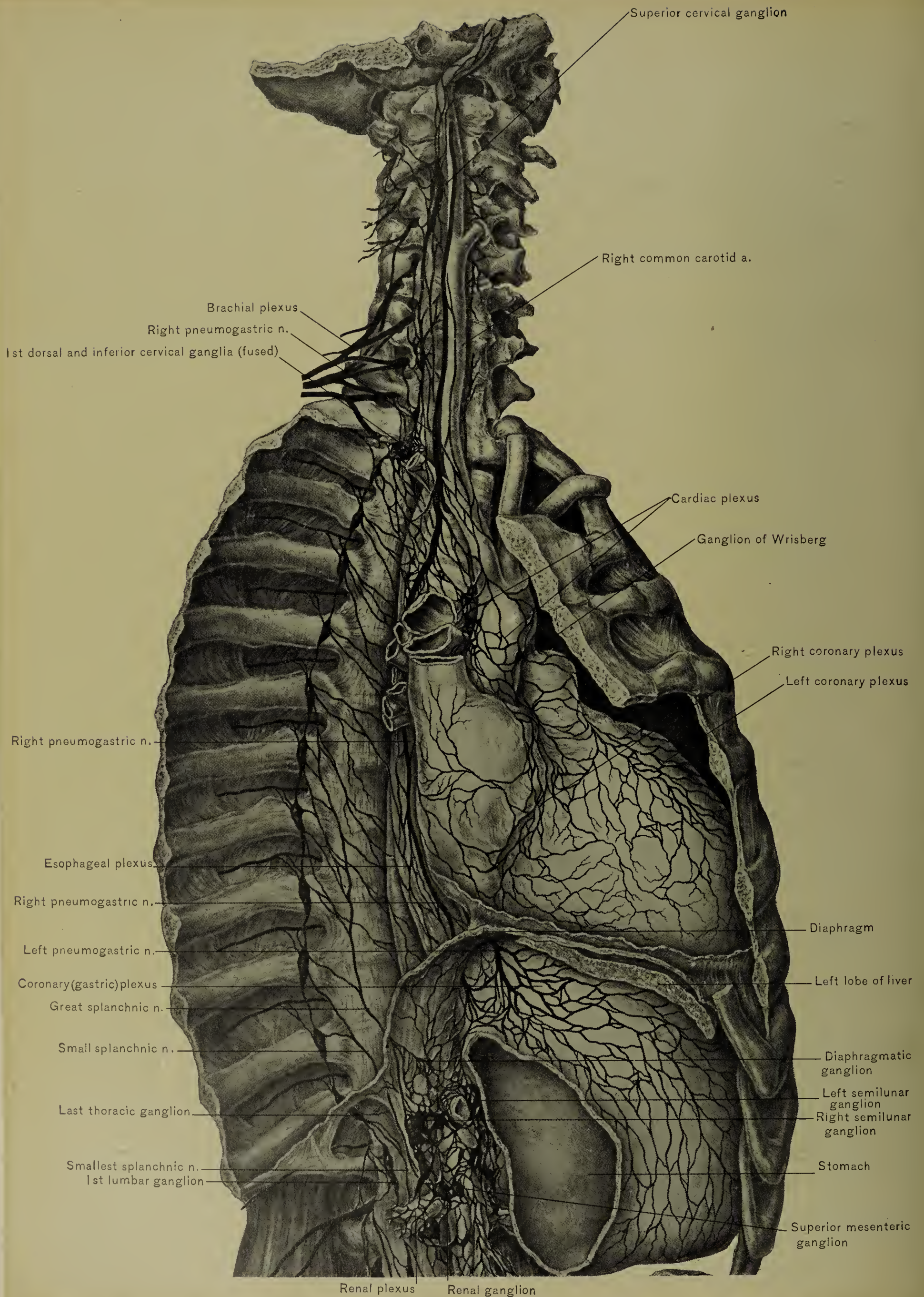
The **common iliac vein** is formed by the union of the external and internal iliac veins, opposite the sacro-iliac articulation. The *right common iliac vein* is shorter and holds a more nearly vertical course than the left. It lies behind, and then to the outer side of, the right common iliac artery. The *left common iliac vein* is longer than the right, and runs a more oblique course. It lies on the inner side of the left common iliac artery, and then crosses beneath the right common iliac artery to join the right common iliac vein, in front of the right side of the body of the fifth lumbar vertebra, to form the inferior vena cava.

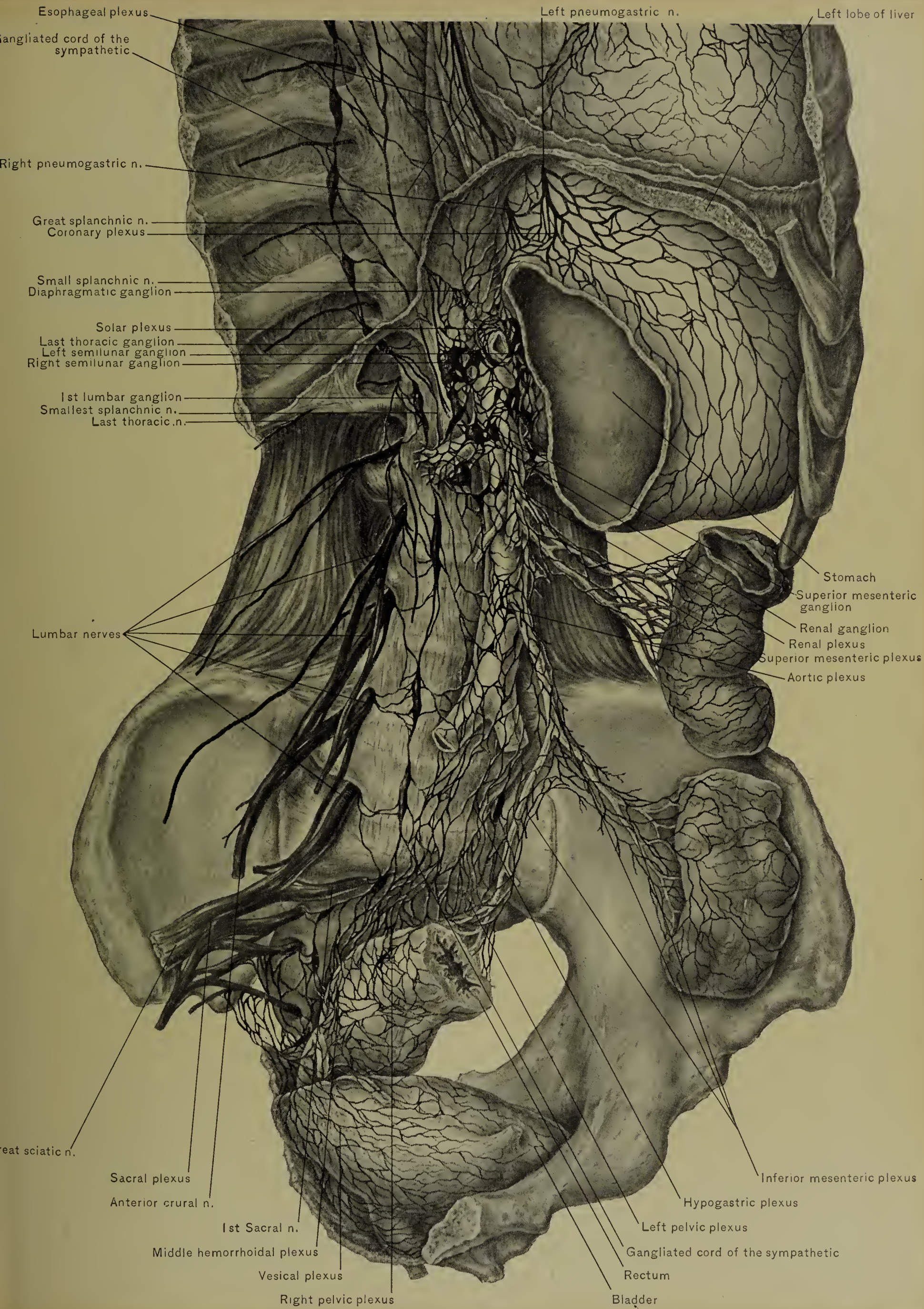
The **external iliac vein** is the continuation of the common femoral vein; the point at which its title changes being at the lower border of Poupart's ligament. It passes upward along the brim of the pelvis, and joins the internal iliac vein to form the common iliac vein opposite the sacro-iliac synchondrosis. On the right side, the external iliac vein lies to the inner side of the artery at first, but soon passes behind it; and, on the left side, it remains to the inner side of the artery throughout its entire course. The tributaries of the external iliac vein are the deep epigastric and deep circumflex iliac veins.

The **deep epigastric vein** is a short vessel formed by the union of the venæ comites of the deep epigastric artery. It empties into the external iliac vein a short distance above Poupart's ligament.

The **deep circumflex iliac vein** is formed by the union of the two veins which accompany the deep circumflex iliac artery. It crosses the external iliac artery just above Poupart's ligament, and joins the external iliac vein a little higher than the deep epigastric vein.

The Abdominal Sympathetic.—The sympathetic system of cords and ganglia enters the abdomen behind the internal arcuate ligaments which span the psoas magnus muscles, or through the crura of the diaphragm, and passes downward along the front of the bodies of the lumbar vertebræ. In the abdomen proper is the **lumbar portion of the gangliated cord**, which contains four or five ganglia. The





ABDOMINAL SYMPATHETIC NERVES.

chains of ganglia enter the pelvis behind the common iliac arteries. A ganglion is found upon the body of each vertebra, and gives off external and internal branches. Some of the **internal branches** pass directly to the aortic plexus, and some pass along the common and internal iliac arteries to the hypogastric and pelvic plexuses. The **external branches**, or **rami communicantes**, run in pairs, accompany the lumbar arteries beneath the tendinous arches from which the psoas muscle arises, and join the anterior primary divisions of the lumbar nerves just external to the intervertebral foramina. (These rami communicantes in the lumbar portion of the sympathetic system are longer than elsewhere.)

The **Solar** or **Epigastric Plexus** is a thick network of nerves and ganglia wound around the celiac axis and the origin of the superior mesenteric artery. It rests upon the aorta and the crura of the diaphragm. It occupies the middle position, and is the largest in size of the **three prevertebral plexuses** of the sympathetic portion of the nervous system. These plexuses are: The **cardiac**, in the chest; the **solar**, in the abdomen; and the **hypogastric**, in the pelvis. The solar plexus extends downward to the pancreas and laterally to the suprarenal bodies. It receives the lesser splanchnics and branches of the vagi. It gives off branches which are distributed along all the branches of the abdominal aorta, around which they form networks or plexuses. These plexuses bear the same names as the vessels to which they are related.

The **semilunar ganglia**, two in number, are parts of the solar plexus, in either side of which they lie, and are formed by aggregations of smaller ganglia. They lie between the suprarenal bodies, laterally, and on each side of the celiac axis which they embrace in their concavities, and are united on their internal sides. The right is behind the inferior vena cava. After piercing the diaphragm the great splanchnic nerves enter the convex sides of the ganglia.

The branches of the solar plexus are, named from above downward, the phrenic, the celiac, the gastric, the hepatic, the splenic, the suprarenal, the renal, the superior mesenteric, the aortic, the spermatic or ovarian, and the inferior mesenteric plexuses. They have been described in discussing the viscera to which they go, except in the following details:

The **phrenic** or **diaphragmatic plexuses** arise from the upper end of the semilunar ganglia, the right being the larger. At the communication between the right phrenic plexus and the phrenic nerve there is a ganglion (*ganglion diaphragmaticum*) which lies on the under surface of the diaphragm near the suprarenal body.

The **suprarenal plexuses** are derived from the solar, the phrenic, and the renal plexuses. They are distributed to the medullary portions of the suprarenal bodies.

The **renal plexuses** are formed from the solar plexuses, the outer parts of the semilunar ganglia, the aortic plexus, and the lesser and smallest splanchnic nerves, and each consists of from fifteen to twenty nerves studded with ganglia. Branches from these plexuses enter the hilum of the kidneys, accompanying the arteries.

The **celiac plexus** is large and is a direct continuation of the solar plexus. It surrounds the celiac axis, and divides into the *gastric*, *hepatic*, and *splenic plexuses*, which accompany the vessels of the same name and their branches to their ultimate destination.

The **superior mesenteric plexus** is derived from the lower part of the solar plexus and a branch from the right vagus, accompanies the superior mesenteric artery, and contains a few ganglia (*ganglia mesenterica*). Its subdivisions receive names corresponding to the branches of the artery.

The **aortic plexuses** are, practically, the continuations of the solar plexus on each side of the abdominal aorta, and are joined by branches from the upper three lumbar nerves. They are connected by transverse branches which cross in front of the aorta, and give origin to the spermatic or ovarian and inferior mesenteric plexuses, and terminate in branches to the hypogastric plexus.

The **spermatic plexuses** are derived from the renal and aortic plexuses. Each plexus follows the spermatic artery to the internal abdominal ring, where it is joined by branches of the inferior hypogastric or pelvic plexuses. These last branches accompany the vas deferens to the internal abdominal ring. The plexus then follows the artery to the testicle. In the female the plexus follows the ovarian artery to the ovary and uterus.

The **inferior mesenteric plexus** arises from the left side of the aortic plexus, and accompanies the inferior mesenteric artery and its branches.

The Lumbar Nerves.—The lumbar nerves are five in number upon each side, and emerge at the intervertebral foramina. They are numbered from above downward, and divide into anterior and posterior branches.

The **posterior divisions** of the lumbar nerves have been described with the back.

The **anterior divisions** increase in size from above downward, and enter into the lumbar and sacral plexuses. They communicate with the lumbar sympathetic ganglia by long slender filaments, or rami communicantes, and supply muscular branches to the psoas magnus and quadratus lumborum muscles.

The **lumbar plexus** is formed by the intercommunication of the anterior divisions of the upper four lumbar nerves and a communicating twig from the anterior division of the last thoracic nerve, the dorsi lumbar nerve. It is placed in front of the transverse processes of the lumbar vertebræ, within the substance of the psoas magnus muscle. A branch from the fourth lumbar nerve and the fifth lumbar nerve form the lumbo-sacral cord, which connects with the sacral

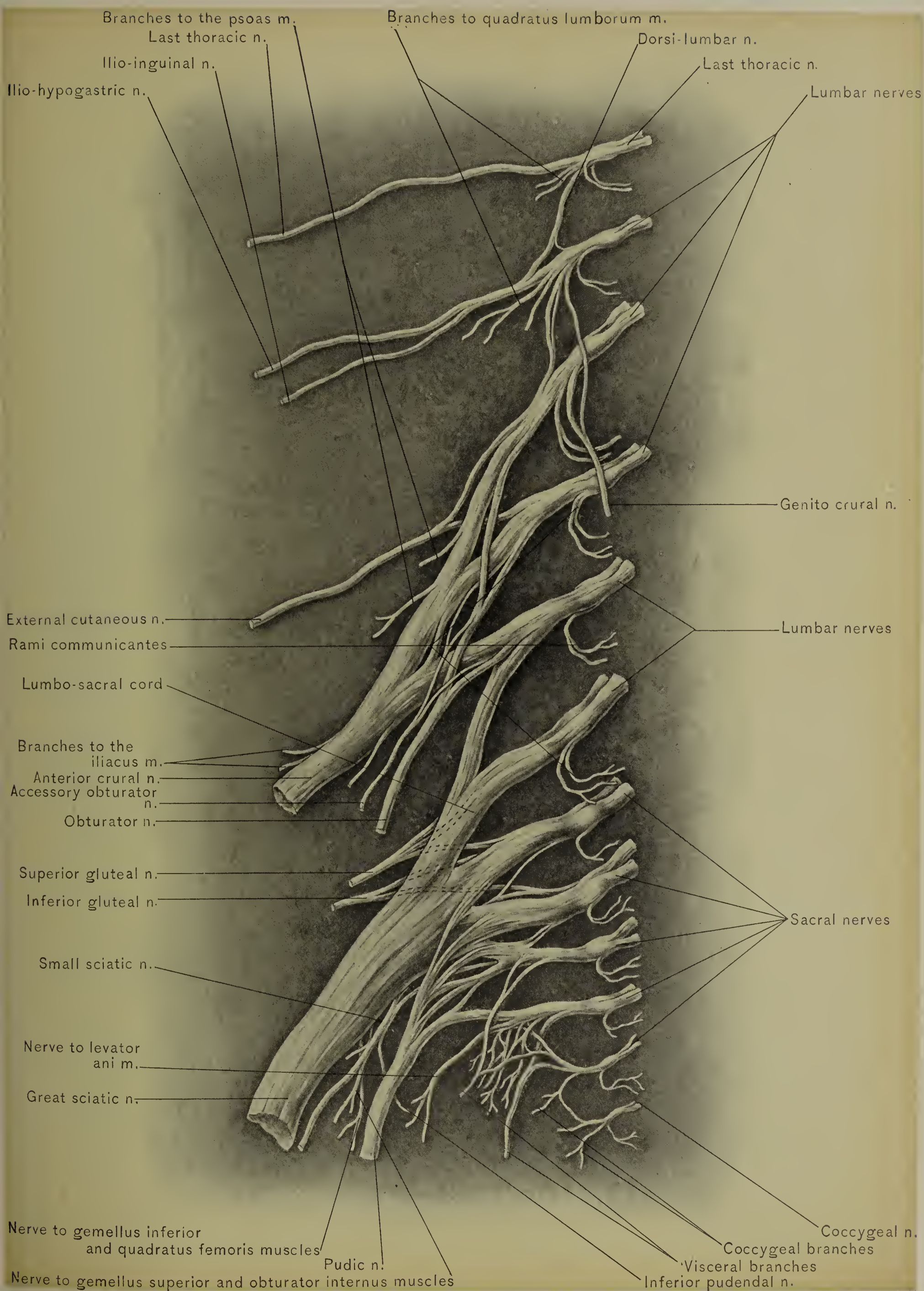


DIAGRAM OF THE LUMBAR AND SACRAL PLEXUSES.

plexus. The branches of the lumbar plexus are: The ilio-hypogastric and the ilio-inguinal nerves, which are derived from the first lumbar nerve; the genito-crural nerve, which is derived from the first and second lumbar nerves; the external cutaneous nerve, from the second and third lumbar nerves; the obturator and the anterior crural nerve, from the second, third, and fourth lumbar nerves; and the accessory obturator nerve (inconstant), from the third and fourth lumbar nerves.

The **ilio-hypogastric nerve** is a branch of the anterior division of the first lumbar nerve. It passes through the upper part of the outer border of the psoas magnus muscle, and runs in the extraperitoneal fat obliquely downward and outward across the front of the quadratus lumborum muscle to the crest of the ilium, where it pierces the transversalis muscle. It runs forward along the crest of the ilium, between the transversalis and internal oblique muscles, and divides into an iliac and a hypogastric branch about two and one-half inches (six centimeters) behind the anterior superior spine of the ilium. The *iliac branch* passes through the internal and external oblique muscles above the crest of the ilium, and supplies the skin of the gluteal region behind the area of distribution of the lateral cutaneous or iliac branch of the last thoracic nerve. The *hypogastric branch* passes forward along the crest of the ilium, pierces the internal oblique muscle at the level of the anterior superior spine of the ilium, and passes through the aponeurosis of the external oblique muscle about an inch (2.5 centimeters) above the external abdominal ring. It sends *muscular branches* to the rectus abdominis and pyramidalis muscles, and *cutaneous branches* to the skin over the hypogastrium. The ilio-hypogastric nerve and its branches supply the external oblique, internal oblique, transversalis, rectus abdominis, and pyramidalis muscles, and the skin of the hypogastrium and of that portion of the gluteal region below the anterior part of the crest of the ilium.

The **ilio-inguinal nerve** arises in common with the preceding nerve from the anterior division of the first lumbar nerve. It is situated below the ilio-hypogastric nerve, diverges from it in its onward course, and crosses the upper part of the iliacus muscle to pierce the transversalis muscle near the anterior extremity of the iliac crest. It communicates with the ilio-hypogastric nerve above the iliac crest, where it lies between the transversalis and internal oblique muscles, both of which it supplies. It passes through the internal oblique muscle anterior to the anterior superior spine of the ilium, and runs in front of the cremaster muscle and spermatic cord or round ligament through the inguinal canal, from which it emerges at the external abdominal ring. It supplies *muscular branches* to the transversalis, internal oblique, rectus abdominis, and pyramidalis muscles, and to the dartos, and *cutaneous branches* to the skin of the scrotum or labium and the upper and inner parts of the thigh.

The **genito-crural nerve** arises from the anterior divisions of the first and second lumbar nerves by two roots which pass obliquely through the psoas magnus muscle, and unite on the surface of the muscle to form a single nerve. The nerve runs downward in the extraperitoneal fat upon the psoas muscle, and upon the outer side of the external iliac vessels and above Poupart's ligament, divides into a genital and a crural branch.

The *genital branch* accompanies the spermatic vessels through the inguinal canal and abdominal rings. Its branches pierce the internal spermatic fascia to supply muscular filaments to the cremaster muscle. In the female it accompanies the round ligament.

The *crural branch* runs under Poupart's ligament, and passes into the outer compartment of the femoral sheath and sends off filaments to the femoral artery. It then pierces the outer side of the femoral sheath, and passes through the fascia lata a little below Poupart's ligament and external to the femoral artery. It gives off cutaneous branches to the antero-external aspect of the thigh, and a *communicating branch* to join the middle cutaneous nerve.

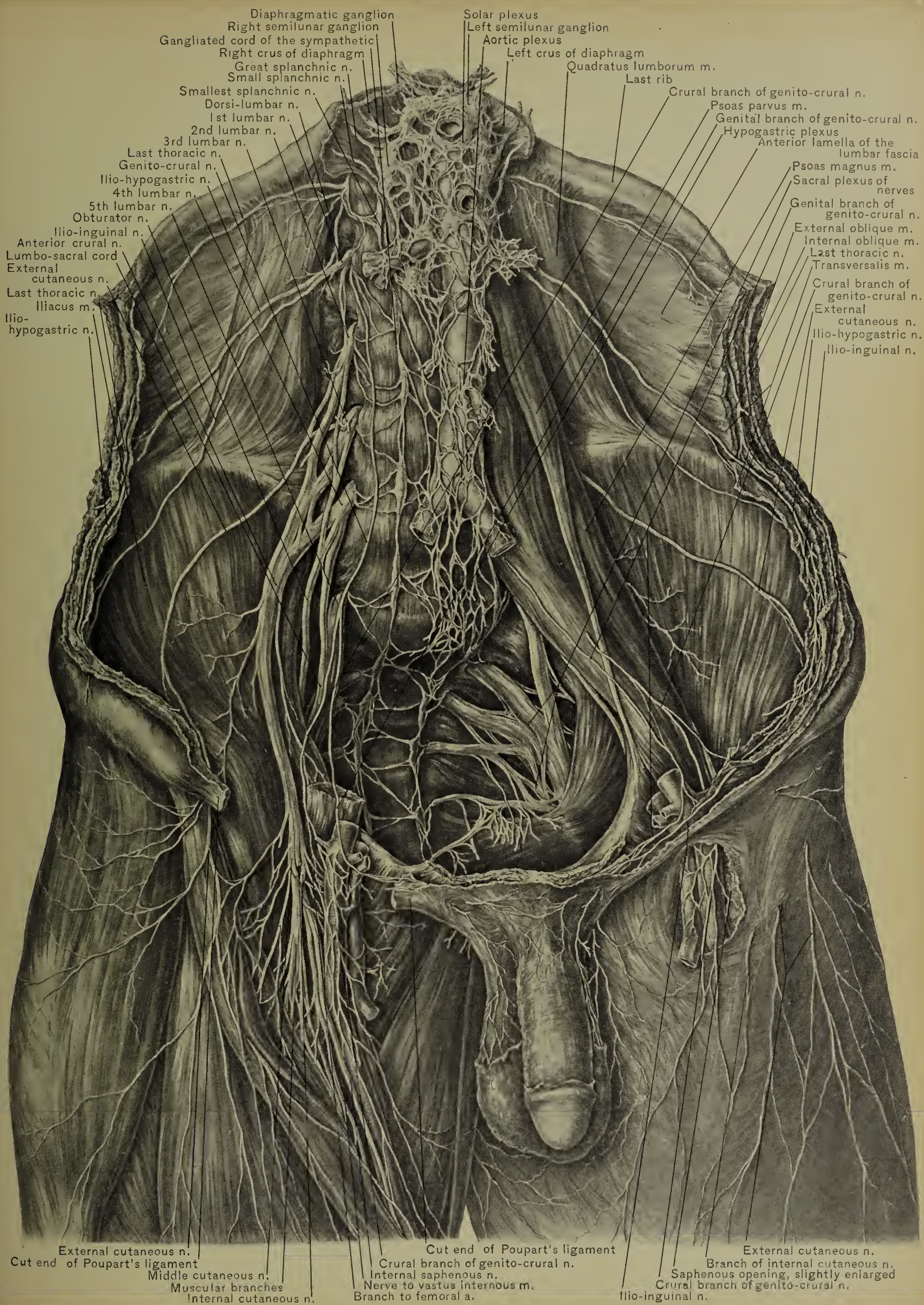
The **external cutaneous nerve** arises from the anterior divisions of the second and third lumbar nerves. It pierces the outer border of the psoas magnus muscle, and passes through the extraperitoneal fat obliquely across the iliacus muscle toward the anterior superior iliac spine. At this point it passes under Poupart's ligament into the thigh. Then it divides into an anterior and a posterior branch.

The *anterior branch* continues downward in the fascia lata, and pierces it about four inches (ten centimeters) below the anterior superior iliac spine, to supply the skin of the antero-external aspect of the thigh as far as the knee. It communicates with the middle cutaneous nerve, and sometimes with the long saphenous nerve.

The *posterior branch* perforates the fascia lata and supplies the skin of the postero-external part of the upper half of the thigh.

The **obturator nerve** takes its origin from the anterior divisions of the second, third, and fourth lumbar nerves. It passes between the psoas magnus muscle and the body of the fifth lumbar vertebra, and then runs in the extraperitoneal fat below and parallel with the inner border of the psoas magnus, and below the level of the pelvic brim. In the latter part of its course it accompanies and lies above the obturator vessels, with which it passes through the deficiency in the obturator membrane at the upper part of the obturator foramen. On emerging from the pelvis it divides into an anterior and a posterior branch, which are described with the lower extremity.

The **accessory obturator nerve** is frequently absent, and, when present, arises from the anterior divisions of the third and fourth lumbar nerves, from the roots



THE LUMBAR PLEXUS.

of the obturator, or from the trunk of this nerve. It passes along the inner border of the psoas magnus muscle, and across the horizontal ramus of the pubis, to the under surface of the pectineus muscle, behind which it divides into branches. These branches are muscular to the pectineus, articular to the hip-joint, and communicating to the obturator nerve.

The **anterior crural nerve**, the largest branch of the plexus, arises from the anterior divisions of the second, third, and fourth lumbar nerves. Its roots pass through the deep portion of the psoas magnus muscle, and, emerging on the deep surface of the muscle, the roots unite into a single trunk which runs under the iliac fascia in the deep groove between the psoas and the iliacus muscles. It passes under Poupart's ligament into the thigh, where it lies external to the common femoral vessels. It lies under the iliac fascia while passing under Poupart's ligament. Within the lower abdomen it gives off three or four muscular branches which pass outward to the anterior surface of the iliacus. It also supplies a vascular filament which usually takes its origin a little above Poupart's ligament, but may arise considerably higher or lower. It is always present, and never fails to supply the common femoral artery, although its origin may vary. The branches of the anterior crural nerve given off in the thigh are described with the lower extremity.

The anterior branch of the fifth lumbar nerve receives a fasciculus from the fourth lumbar nerve, and is then called the **lumbo-sacral cord**, which passes downward to join the first sacral nerve, and thus assists in the formation of the sacral plexus.

Reflex retraction of the testis is caused through peripheral irritation of the genito-crural nerve. Neuralgia of any of the branches of the lumbar nerves may be caused by lumbar caries, lymphadenoma, cancer, abscess, aneurysm, neuritis, or a number of other intra-abdominal disturbances.

The **Lumbar Spine** is the largest part of the spinal column in all dimensions except in length. Its bodies are thicker and wider, being bean- or kidney-shaped; its spinous processes are quadrilateral and more massive, and its transverse processes are very long, and consist of a costal and a transverse portion. Occasionally the costal portion of the transverse process is developed into a true lumbar rib. Numerous muscles are attached to it. It bears a greater strain than does any other part of the spinal column, and is most frequently affected by inflammation following injuries, for it must bear the weight of the superimposed parts at all angles. When injured and in urgent need of rest for the purpose of repair, it is almost unceasingly mobile, for there is motion in the lumbar spine, due to breathing alone, while the patient lies upon the back. The patient can not turn in bed without subjecting it to strain. These reasons are, therefore, amply sufficient to

explain the tenacity with which injury or disease of the lumbar vertebræ clings to its victim. In a thin person considerably more than half of the antero-posterior diameter of the abdominal portion of the trunk above the umbilicus is taken up between the skin of the back and the front of the bodies of the vertebræ.

THE DIAPHRAGM.

The diaphragm is the chief muscle of inspiration. It is a dome-shaped, musculo-aponeurotic sheet, which is a partition wall between the thoracic and abdominal cavities. Its upper or thoracic surface is convex, and its lower or abdominal surface is concave. It forms the floor of the thoracic and the roof of the abdominal cavity.

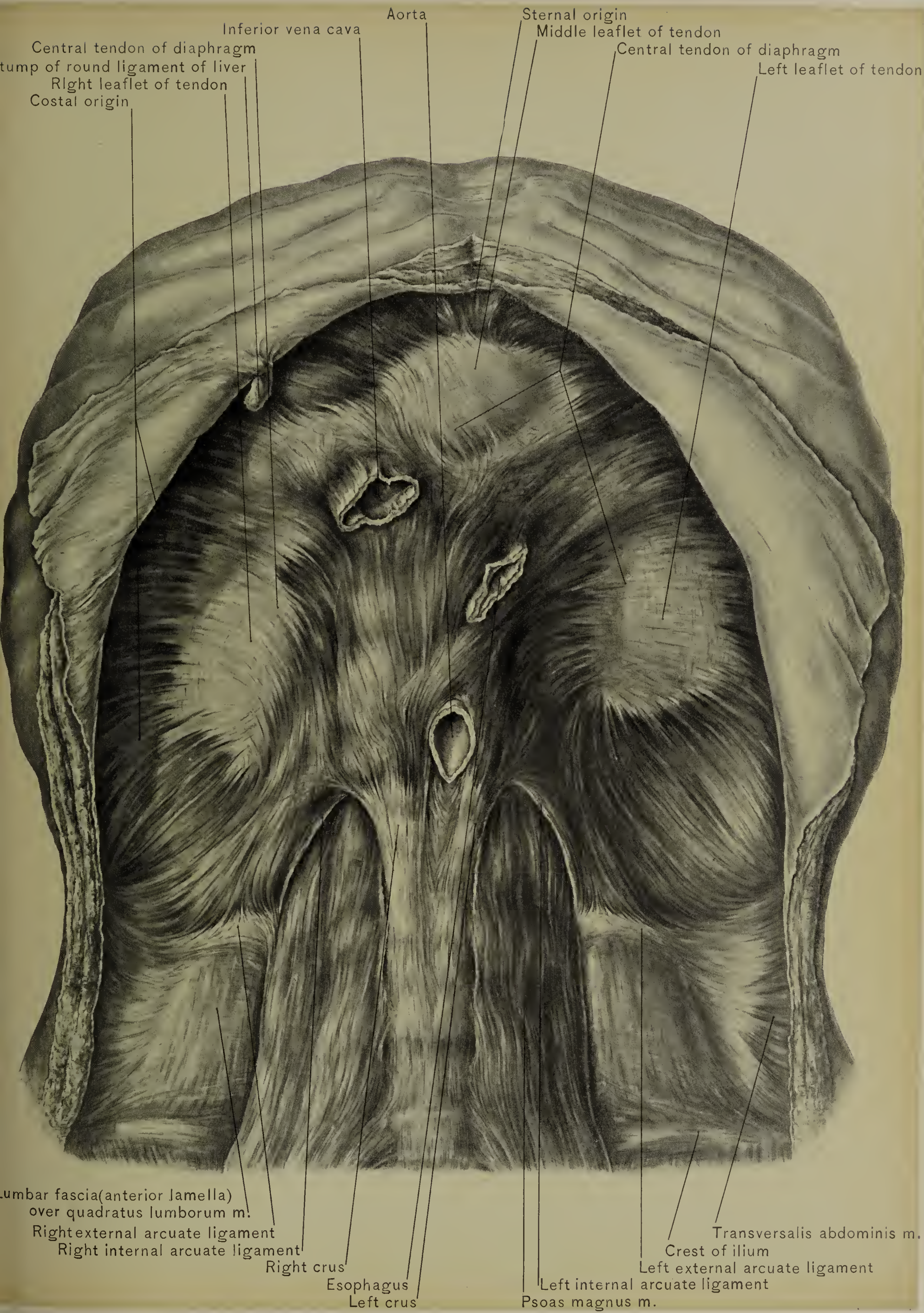
On account of the presence of the liver on the right side, the dome ascends higher there, and extends to the level of the fifth chondro-sternal articulation, while on the left it reaches only to the level of the sixth chondro-sternal articulation.

It arises from the whole circumference of the lower margin of the thoracic wall. Therefore it arises from the internal surface of the ensiform cartilage, the cartilage and bony ends of the lower six or seven ribs, the bodies of the lumbar vertebræ and two aponeurotic arches, and the ligamenta arcuata interna and externa. The fibers from the various attachments or points of origin vary in length. Thus, those from the ensiform cartilage are very short, while those from the ligamentous arches and from the lateral points of origin are much longer. The fibers converge for insertion into the central tendon. It will be noticed that the fibers from the ensiform cartilage and those from the adjoining costal cartilages do not lie in contact. In consequence of this there is generally found a space on each side of the ensiform cartilage which is filled in with areolar tissue, and which may be traversed by a diaphragmatic hernia.

The **Ligamentum Arcuatum Internum** consists of a fibrous arch of fibers which is thrown across the upper end of the psoas magnus muscle, and is a thickened part of the psoas portion of the iliac fascia. It extends from the side of the body of the second lumbar vertebra, where it is continuous with the crus of that side, to the tip of the transverse process of the same vertebra.

The **Ligamentum Arcuatum Externum** is the thickened upper part of the anterior layer of the lumbar fascia. It extends from the tip of the transverse process of the second lumbar vertebra to the tip and lower margin of the last rib.

The diaphragm arises from the spinal vertebræ by two tendinous elongated bundles, the **Crura of the Diaphragm**. They have tendinous origins, the right



THE DIAPHRAGM.

arising from the bodies of the first, second, third, and fourth lumbar vertebræ, intervening cartilages, and the anterior common ligament; and the left, from the bodies of the first, second, and third lumbar vertebræ, the anterior common ligament, and the intervertebral discs. Both crura blend with the anterior common ligament of the spine. The crura converge, after passing forward and inward, and join in the middle line, forming an arch. Behind this arch is the aortic opening of the diaphragm, through which pass the aorta, the vena azygos major, and the thoracic duct. Muscular fibers arise from this tendinous arch and pass upward and outward for insertion into the central tendon. The inner fibers, however, decussate above the aorta and surround the esophagus. In this decussation the fibers of the right side are the more anterior.

The **Central Tendon of the Diaphragm** is an aponeurotic sheet which is located near the center of the dome. Its superior surface is in relation with the pericardium, and at its circumference gives attachment to that membrane. The central tendon is composed of three divisions or leaflets which vary in size, the right being the largest, the left, the smallest, and the middle, or ensiform, intermediate in size. The tendon is made up of several layers of fibers which intermingle and cross one another, so as to give additional strength to it.

The main **Openings in the Diaphragm** are the aortic, the esophageal, and the opening for the inferior vena cava.

The **aortic opening** is formed by the arch made by the fibrous junction of the crura of the diaphragm. It is located immediately in front of the spinal column, opposite the body of the twelfth thoracic vertebra, and transmits the aorta, the vena azygos major, and the thoracic duct. At times the left sympathetic nerve also passes through this opening. In some instances fibers from the sides of the vertebræ pass beneath the aorta, and thus convert the opening into a fibrous ring which is situated within the diaphragm, although the aortic opening is usually behind the diaphragm, and completed posteriorly by the anterior common ligament.

The **esophageal opening** is an elliptic orifice in the diaphragm, with its long diameter directed antero-posteriorly, bounded by the decussating inner muscular fibers from the crura which embrace the esophagus. It is placed above, anterior to, and to the left of the aortic opening, on a level with the body of the tenth thoracic vertebra. It transmits the esophagus and the pneumogastric nerves, and esophageal branches of the thoracic aorta. At times the anterior margin of the opening is tendinous, and formed by the margin of the central tendon.

The **opening for the inferior vena cava** (foramen quadratum) is quadrate in shape, and situated close behind the central tendon, at the junction of the right and middle leaflets of the tendon. It is higher than the other main openings.

Through it pass the inferior vena cava, a few lymphatics from the convex surface of the liver, and, generally, a branch from the right phrenic nerve. The walls of the vein are attached to the margins of the opening, and in this manner the terminal portion of the vein is continually held open.

Openings in the right crus transmit the sympathetic and greater and lesser splanchnics of the right side; those in the left crus, the greater and lesser splanchnic nerves of the left side and the vena azygos minor.

RELATIONS.—The diaphragm is in relation with the two pleuræ and the pericardium on its convex, or thoracic, surface, and with the peritoneum on its concave surface. The organs in relation with it, above, are the lungs and the heart; below it is in relation with the liver and its ligaments, the stomach, the spleen, the pancreas, the kidneys, and the suprarenal capsules.

BLOOD SUPPLY.—The blood supply of this muscle is derived from the two phrenic branches of the aorta, the musculo-phrenic branches of the internal mammary arteries, and from the lower intercostal arteries.

NERVE SUPPLY.—The nerve supply of the diaphragm is derived from the phrenic nerves and the five or six lower intercostal nerves. Small filaments are also sent to the diaphragm from the diaphragmatic plexuses, which are derived from the semilunar ganglia and solar plexus. At the point where the plexus joins filaments of the right phrenic nerve, on the under surface of the diaphragm, close to the right suprarenal capsule, is situated the **ganglion diaphragmaticum**. Branches of this ganglion are given off to the liver, the inferior vena cava, and the suprarenal capsule. This ganglion is absent on the left side.

ACTION.—The action of the diaphragm is to deepen the chest from above downward; thus it is a powerful muscle of inspiration. When acting in conjunction with the abdominal muscles, it is a powerful force in the expulsion of feces and urine, and assists in parturition and in emesis. By its spasmodic contractions it plays an important rôle in coughing, sneezing, laughing, etc.

During contraction of the muscle the central tendon is but little, if at all depressed. By their contraction, however, the fibers radiating from this central portion deeply depress the sides of the vault, and thus deepen the chest cavity. When contracting with the abdominal muscles, the diaphragm forms a barrier against which the abdominal viscera may be compressed.

When the diaphragm is paralyzed, respiration is performed by the intercostals and the accessory muscles of respiration.

Hiccup is produced by clonic or intermittent spasm of the diaphragm. It is caused by irritation of the phrenic nerve or some irritation referred through the sympathetic fibers of the diaphragmatic plexuses. Thus hiccup often occurs after a meal or from distention of the stomach, or in pleurisy, pericarditis, and

peritonitis. The last three conditions, however, more commonly cause a dry cough.

The **Iliac Fascia** is a dense, fibrous membrane which covers the iliacus and psoas muscles and the lumbar plexus, and on which rest the iliac arteries. Externally this fascia is attached to the inner lip of the crest of the ilium, along which it is continuous with the transversalis fascia and the anterior lamella of the lumbar fascia, and internally to the ilio-pectineal line, along which it is continuous with the pelvic fascia. It may be divided into two portions—that covering the iliacus and that investing the psoas muscle.

The portion covering the iliacus muscle is attached externally to the whole length of the inner border of the crest of the ilium, and internally to the brim of the pelvis. This portion of the fascia is intimately connected with the portion of Poupart's ligament which is external to the line of the external iliac vessels. Behind the vessels it descends into the thigh, thus forming the posterior wall of the sheath of the femoral vessels. At the inner side of the vessels it is attached to the ilio-pectineal line behind the conjoined tendon. It becomes continuous with the transversalis fascia on the inner and outer sides of the external iliac vessels. Abscess beneath this fascia points below Poupart's ligament on the outer side of the femoral vessels, and may pass over the brim of the pelvis and beneath the pelvic fascia to the perineum or gluteal region.

The portion in relation with the psoas magnus muscle is attached internally to the base of the sacrum, the upper and lower margins of the bodies of the lumbar vertebræ, and the intervertebral discs, thus forming tendinous arches over the concavities of the bodies of the vertebræ. These arches give origin to the psoas muscle, and transmit the lumbar vessels and branches of the sympathetic nerve (rami communicantes). Above, it forms the ligamentum arcuatum internum. Below the crest of the ilium the psoas portion of the iliac fascia becomes continuous externally with the portion which covers the iliacus muscle. Above the iliac crest it is attached externally to the anterior layer of the lumbar fascia near the tips of the transverse processes of the vertebræ.

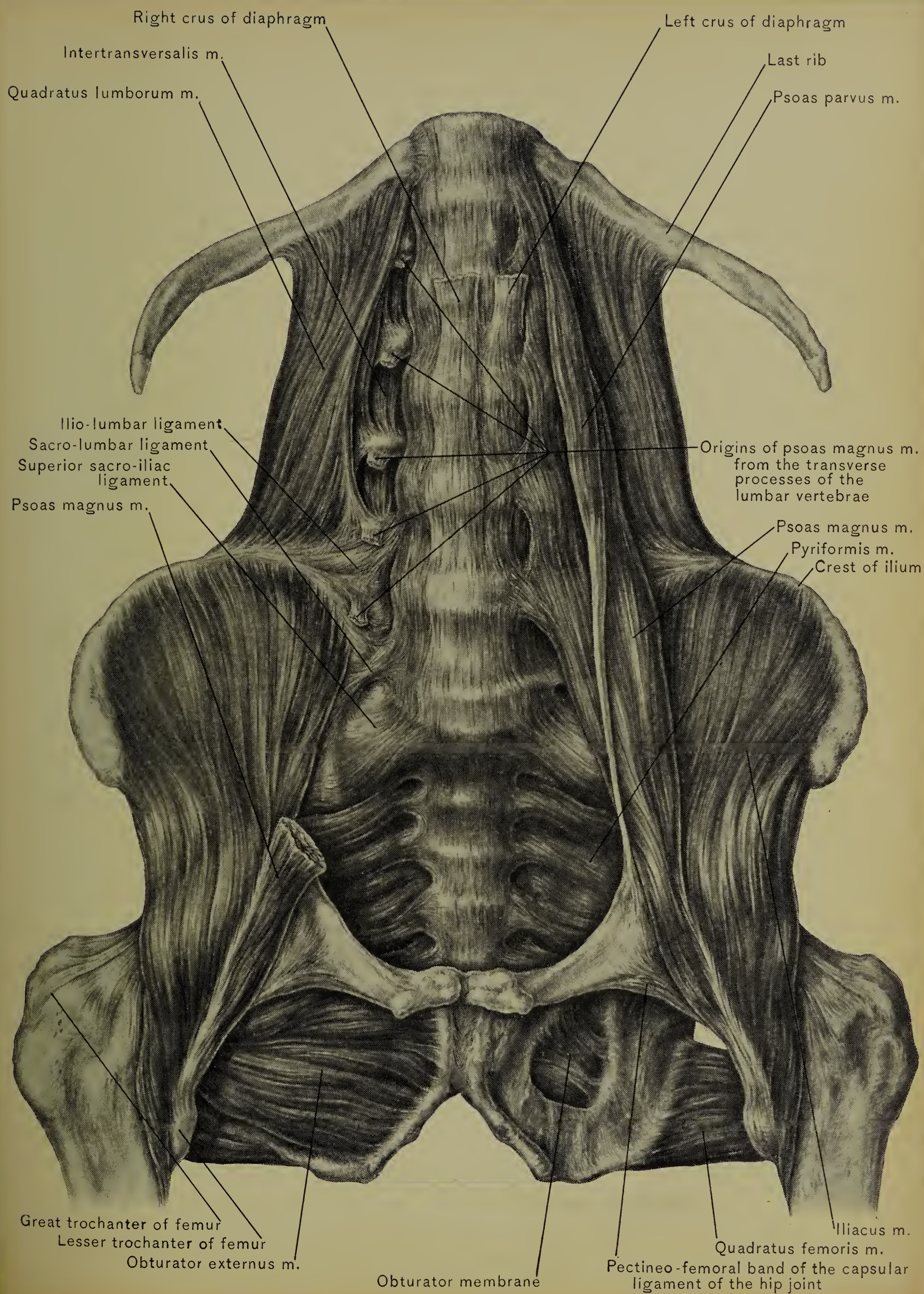
At the point where the iliac fascia is attached to the ilio-pectineal line it is continuous with the pelvic fascia. Internal to the psoas it is also attached to the capsular ligament of the hip-joint and to the horizontal ramus of the pubis, becoming continuous with the pubic portion of the fascia lata. Opposite the outer half of Poupart's ligament the iliac and transversalis fasciæ blend, and are there closely united to that ligament. Beneath the inner part of that ligament these fasciæ do not blend, but continue downward upon the common femoral vessels. The iliac fascia is behind, and the transversalis fascia lies in front of, them. Thus is formed the femoral sheath, which is described with the lower

extremity. Below Poupart's ligament the iliac fascia continues to cover the psoas and iliacus muscles and the anterior crural nerve.

In cases of psoas abscess, which is usually due to caries of the vertebræ, the direction in which the pus will burrow is determined by this portion of the iliac fascia. If this fascia, which forms the sheath of the psoas muscle, remain intact, the pus will follow the course of the muscle and present below Poupart's ligament, at the outer side of the femoral vessels. If the pus break through the sheath of the psoas, the collection will occupy the iliac fossa; it may gravitate into the pelvis, under the pelvic fascia, pass through the great sacro-sciatic foramen, and present in the gluteal region; or it may pass under the pelvic and obturator fasciæ, perforate the obturator fascia, and enter the ischio-rectal fossa. Thus the collection may be mistaken for an iliac, a gluteal, or an ischio-rectal abscess.

The **psoas magnus muscle** is a fusiform muscle which arises by five fasciculi from the transverse processes of all the lumbar vertebræ, from the intervertebral discs, and from the margin of the bodies of the vertebræ between the lower margin of the last thoracic vertebra and the upper margin of the last lumbar vertebra inclusive. The slips are attached to the bodies of the vertebræ only at their prominent margins. Over the concavities of the bodies the muscle-fibers arise from the tendinous arches formed by the psoas portion of the iliac fascia. The fibers converge as they pass downward and outward, the tendon appearing in the center of the muscle, at about the level of the crest of the ilium. The tendon and narrow portion of the muscle pass along the brim of the pelvis, and the tendon passes beneath Poupart's ligament and over the capsule of the hip-joint, to be inserted into the lesser trochanter of the femur. Between the tendon and the capsule of the joint is a bursa which at times communicates with the interior of the joint through the capsule. While passing over the brim of the pelvis the tendon receives part of the insertion of the iliacus muscle. Within the muscle is found the lumbar plexus, the nerves from which run in its substance for some distance.

RELATIONS.—In front of the psoas magnus muscle are the psoas parvus muscle, the iliac fascia, extraperitoneal fat, the genito-crural nerve, the kidney, the renal vessels, the spermatic or ovarian vessels, the ureter, the vas deferens (male), or the round ligament (female), the peritoneum, the intestines, and the external iliac and common femoral vessels. Behind it are the lumbar vertebræ, the anterior lamella of the lumbar fascia, the quadratus lumborum muscle, the brim of the pelvis, the horizontal ramus of the pubis, and the capsule of the hip-joint. To the outer side are the kidney, the colon, the iliacus muscle, and the anterior crural nerve. On the inner side are the crus of the diaphragm, bodies of the lumbar vertebræ, the lumbar arteries, the lumbar glands, the obturator nerve, the



QUADRATUS LUMBORUM, PSOAS, AND ILIACUS MUSCLES.

sympathetic ganglia and nerve, and the external iliac vessels. The aorta lies to the inner side of the left psoas muscle, and the inferior vena cava to the inner side of the right psoas.

BLOOD SUPPLY.—The blood supply of the psoas muscle is derived chiefly from the lumbar and ilio-lumbar arteries.

NERVE SUPPLY.—The nerve supply of the psoas is derived from the lumbar plexus.

ACTION.—The psoas magnus muscle acts as a powerful flexor of the thigh upon the pelvis. When acting from below, the psoas will flex the lower thoracic and the lumbar portions of the spinal column upon the pelvis, and the pelvis on the thigh. Owing to the angle formed by the neck of the femur with the shaft, the muscle can not act as an external rotator of the thigh, as the point of insertion of the psoas muscle is external to the axis around which the limb rotates, and therefore the muscle may act as an internal rotator of the thigh.

The action of the psoas is well shown in coxitis or hip disease, in which irritation of this muscle causes it to be in a state of continuous or tonic contraction. Therefore the thigh is flexed upon the pelvis, and when the thigh is brought into a line with the trunk, the pelvis is flexed on the thigh and the lumbar portion of the spinal column is arched forward.

The **iliacus muscle** is wide and triangular. It arises from the upper half of the iliac fossa, the inner lip of the crest of the ilium, the base of the sacrum, the ilio-lumbar, lumbo-sacral, and anterior sacro-iliac ligaments, the anterior superior spine of the ilium, and the capsular ligament of the hip-joint. The fibers converge and pass downward and inward. The upper fibers join the tendon of the psoas muscle about two inches (five centimeters) above its insertion, and are inserted into the lesser trochanter of the femur; the lowest fibers are continued downward for insertion into the shaft of the femur for about an inch (2.5 centimeters) below the lesser trochanter.

RELATIONS.—In front of the iliacus are the ilio-inguinal, the external cutaneous, and the anterior crural nerve, the iliac fascia, extraperitoneal fat, the peritoneum, and the intestines. The cecum and vermiform appendix are anterior to it on the right side, and the sigmoid flexure on the left side. The deep femoral artery and the sartorius muscle rest upon it in the thigh. Behind it are the ilium, the capsule of the hip-joint, and the rectus femoris muscle. On its inner side is the psoas magnus muscle.

BLOOD SUPPLY.—The blood supply of the iliacus muscle is derived from the ilio-lumbar, the deep circumflex iliac, and the external circumflex artery.

NERVE SUPPLY.—The nerve supply of the iliacus is derived from the anterior crural nerve.

ACTION.—The iliacus, like the psoas, is a flexor of the hip-joint and thigh. When acting from below, it will draw the pelvis forward and flex it on the thigh. It also aids to maintain the erect posture by supporting the spine upon the femur. Since its action is similar to that of the psoas, it probably does not rotate the femur outward, but inward.

The **psoas parvus muscle** is small and frequently absent. It arises from the adjacent borders of the last thoracic and first lumbar vertebræ and the intervening intervertebral disc. The fibers converge and form a tendon which begins about two inches below the origin of the muscle. The tendon is inserted by a broad expansion into the iliac fascia, ilio-pectineal line, and ilio-pectineal eminence.

The muscle lies in front of the psoas magnus muscle and behind the iliac fascia. The tendon lies to the inner side of the psoas magnus muscle as it passes along the brim of the pelvis.

NERVE SUPPLY.—The nerve supply is derived from the first nerve of the lumbar plexus.

The **quadratus lumborum muscle** is a thin, quadrilateral muscle. It arises two inches (five centimeters) beyond the inner lip of the crest of the ilium, near the junction of its middle and posterior thirds, from the ilio-lumbar ligament, and from the tips of the transverse processes of the lower three lumbar vertebræ. It is inserted into the inner or posterior half of the lower border of the last rib, the transverse processes of the upper three or four lumbar vertebræ, and the middle lamella of the lumbar fascia, just external to the transverse processes.

RELATIONS.—In front are the anterior division of the last thoracic nerve, the ilio-lumbar and ilio-hypogastric nerves, the lumbar arteries, the anterior lamella of the lumbar fascia, subperitoneal fat, the kidney, the colon, and the psoas muscle. Along the inner border of the muscle are the intertransversales muscles. The middle layer of the lumbar fascia is behind it and separates it from the erector spinæ muscle.

BLOOD SUPPLY.—Its blood supply is derived from the lumbar arteries.

NERVE SUPPLY.—Its nerve supply is derived from the twelfth thoracic and upper lumbar nerves.

ACTION.—The quadratus lumborum muscle acts as a lateral flexor of the thorax and of the lower thoracic and lumbar regions of the spinal column, and draws the last rib downward, thus assisting in expiration. It is also a lateral flexor of the pelvis when acting from its upper attachments.

THE PELVIC CAVITY.

The **Pelvic Cavity** is that portion of the general abdominal cavity inclosed by the hip bones, sacrum, and coccyx. On the side and in front the hip bones, or innominate bones, bound this cavity, joining in front to form the symphysis pubis; while the sacrum forms its posterior boundary. This general pelvic cavity is divided into the true and the false pelvic cavity.

The **False Pelvic Cavity** is that portion of the cavity which lies above the ilio-pectineal lines, and comes in relation with the hypogastric and iliac regions.

The **True Pelvic cavity**, or the pelvic cavity proper, lies below the level of the ilio-pectineal lines. It has a superior opening or inlet and an inferior opening or outlet.

The **Inlet** of the true pelvic cavity is the cordiform space, bounded in front by the crest of the pubes; behind, by the base of the sacrum; on the sides, by the ilio-pectineal lines. The diameters of the inlet are the antero-posterior (conjugate), the transverse, and the oblique. The **antero-posterior** or **conjugate diameter** extends from the symphysis pubis to the sacro-vertebral angle. It averages about four inches (ten centimeters) in the male, and four and three-fourths inches (twelve centimeters) in the female. The **transverse diameter** extends transversely across the greatest width of the pelvis. It averages about four and one-half inches (eleven centimeters) in the male; and five and one-fourth inches (thirteen centimeters) in the female. The **oblique diameter** extends from the ilio-pectineal eminence, on one side, to the sacro-iliac symphysis on the other. It averages about four and one-fourth inches (ten and one-half centimeters) in the male; and five inches (twelve and one-half centimeters) in the female (Gray).

The **Outlet** of the pelvic cavity is bounded in front by the subpubic ligament and the lower borders of the bodies of the pubic bones; behind, by the tip of the coccyx; and at the sides, by the tuberosities of the ischia. In the undissected subject it will be seen that the inlet is open, but that the outlet is closed by the tissues of the perineum. The diameters of the outlet are the antero-posterior, or conjugate, and the transverse. The **antero-posterior diameter** extends from the lower edge of the subpubic ligament at the symphysis pubis to the tip of the coccyx; it averages about three and one-fourth inches (eight centimeters) in the male and five inches (twelve and one-half centimeters) in the female. The **transverse diameter** extends from the posterior part of one ischiatic tuberosity to a corresponding point on the opposite tuberosity; it averages about three and three-quarter inches (nine and one-half centimeters) in the male, and four and three-quarter inches (twelve centimeters) in the female (Gray).

The **Cavity of the True Pelvis** is basin-shaped. This basin is formed by the

bones of the pelvis with their lining structures of muscles and fasciæ on the sides ; and by the muscles and fasciæ which close in the lower portion, or outlet, below. The **anterior wall** is formed by the pubic bones and sub-pubic ligament. Each **lateral wall** is formed by the innominate bone, the obturator membrane, the internal obturator muscle, and the pelvic fascia. The **posterior wall** is formed by the sacrum, the coccyx, the greater and lesser sacro-sciatic ligaments, the two pyriformis and two coccygeus muscles. The **floor** is formed by the structures which fill the outlet of the pelvis : viz., the recto-vesical fascia, the levatores ani and coccygei muscles, the anal fascia, and the triangular ligament of the urethra.

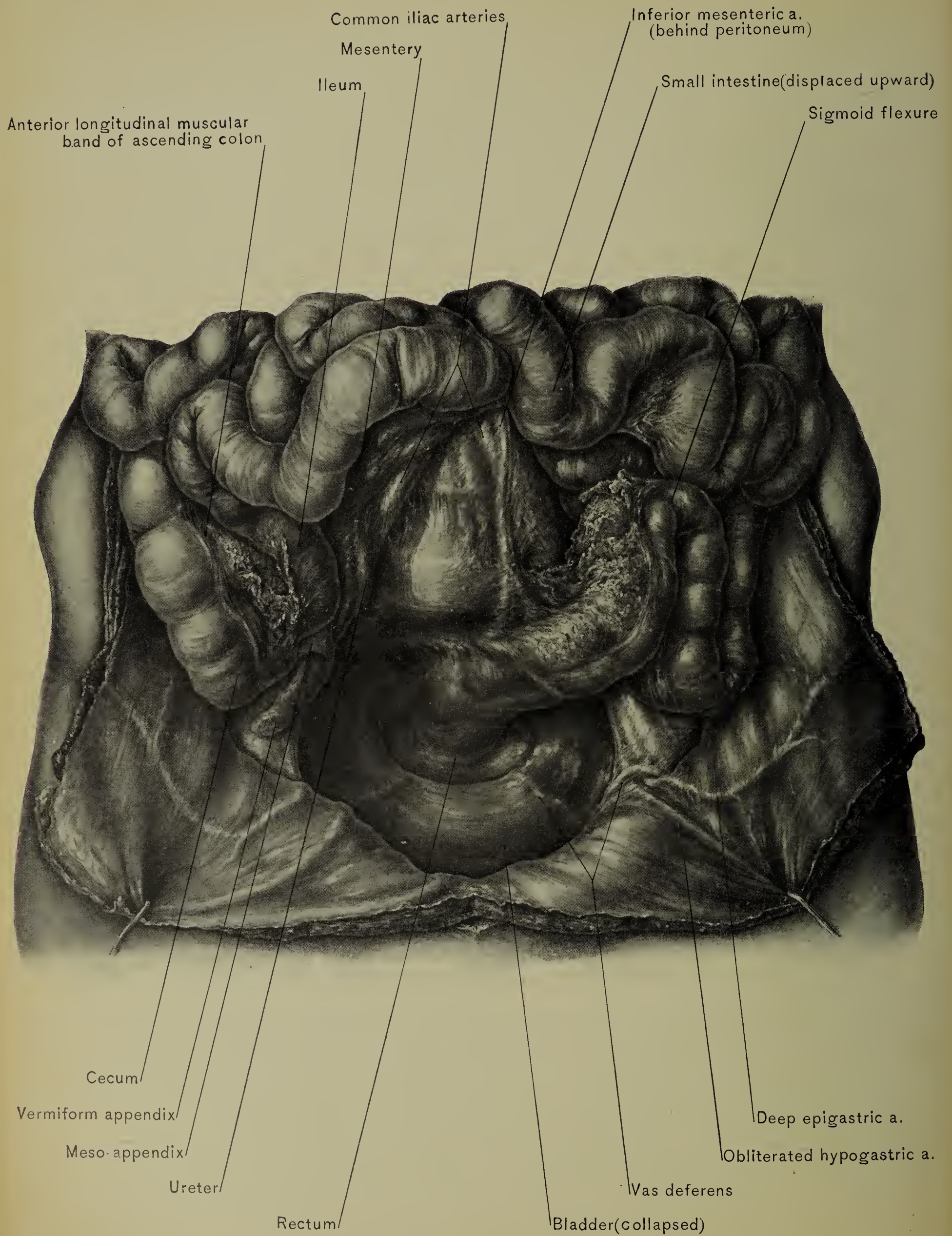
As the visceral layer of the pelvic fascia or recto-vesical fascia forms the lining of the floor of the pelvic basin, a wound should not be described as having penetrated the pelvic cavity if it has not passed through this layer of fascia. The recto-vesical (visceral) layer of the pelvic fascia holds the same relation to the pelvic cavity, in connection with a penetrating or nonpenetrating wound of its floor, as the transversalis fascia does to the abdominal cavity under like conditions.

The pelvic cavity is shallow in front and deep behind. Its posterior wall curves, first downward and backward, and then downward and slightly forward. At its superior opening the cavity is cordiform and wide ; below this point it is nearly circular and its outlet is irregular and narrow. Therefore, the cavity is an inverted, irregular, truncated cone, bent upon itself so that the concavity of the curve is directed forward. This cone becomes greater in circumference, and then rapidly tapers to the pelvic outlet.

The **Axis** of the pelvic cavity is a curved line, which passes through its center parallel to its walls.

The arrangement of the peritoneum and fascia of the pelvic cavity differs in the two sexes in shape, in the distribution of the blood vessels, in the conformation of the muscles filling the outlet, and in the contained generative organs. The bony pelvis of the two sexes differ in several respects. The male pelvis is deeper ; the muscular attachments are more marked ; the bones are thicker ; the symphysis pubis deeper ; the pubic arch is narrower ; and the obturator foramen is elliptic in shape, with the long diameter vertical. The female pelvis is lighter in weight and shallower, but larger in most of its measurements ; the alæ of the ilia are broader and more widely separated, the bones are thinner, the symphysis pubis is more shallow, the pubic arch is wider, the tuberosities of the ischia are more widely separated, the sacrum is wider and less curved, and has a less projecting promontory, and the obturator foramen is approximately triangular in shape.

The contents of the pelvis in both sexes are coils of the small intestine, the sigmoid flexure, rectum, bladder, ureters, vessels, nerves, fasciæ, and peritoneum. The male pelvis contains the prostate gland, prostatic urethra, vasa deferentia, and



PELVIC CAVITY OF MALE—SUPERIOR VIEW.

vesiculæ seminales, in addition to the structures found in the pelvis of both sexes, and the female pelvis contains the urethra, uterus, vagina, ligaments of the uterus, ovaries, and Fallopian tubes.

The number of coils of the small intestine occupying the cavity will depend largely upon the degree of distention of the bladder, and, to a slight extent, of the rectum and sigmoid flexure. After displacing the small intestines and sigmoid flexure, the rectum and bladder can be clearly seen.

The **Sigmoid Flexure**, as described under the dissection of the abdominal cavity proper, chiefly occupies the left side of the pelvis, as a loop which is suspended from the left side of the posterior abdominal wall.

The **Rectum** has been described as divided into three parts. The first of these is, however, commonly included with the sigmoid flexure. The rectum commences opposite the middle piece of the sacrum slightly to the left side of the median line, follows the concavity of this bone and of the coccyx, ending in the median line of the perineum as the anus. It lies immediately behind the bladder in the male, and the uterus and vagina in the female.

The **Bladder** occupies the forepart of the pelvis, being situated between the pubic bones and the rectum in the male, and between the pubic bones in front and uterus and vagina behind in the female.

Lying below the neck of the male bladder is the **Prostate Gland**, the apex of which rests against the superior layer of the triangular ligament. The posterior surface of the prostate is in relation with the anterior wall of the rectum, from which it is separated by connective tissue and unstriped muscular fibers. It surrounds the first or prostatic portion of the urethra.

Between the bladder and the rectum, and behind the prostate, are the **Seminal Vesicles** and the terminal portions of the **Spermatic Ducts** (vasa deferentia), the ducts lying between the vesicles. From the relation existing between the anterior wall of the rectum and the prostate gland, between the rectum and the seminal vesicles, and between the rectum and that portion of the bladder-wall which lies immediately above the prostate and between the seminal vesicles, styled the *bas fond* of the bladder, it follows that much can be learned about the prostate, seminal vesicles, and *bas fond* upon introducing the finger into the rectum. The *bas fond* of the bladder was formerly a favorite point for tapping the bladder in retention of urine by carrying a curved trocar into the rectum and thrusting it through the walls of the rectum and bladder immediately above the base of the prostate which was the guide in the operation.

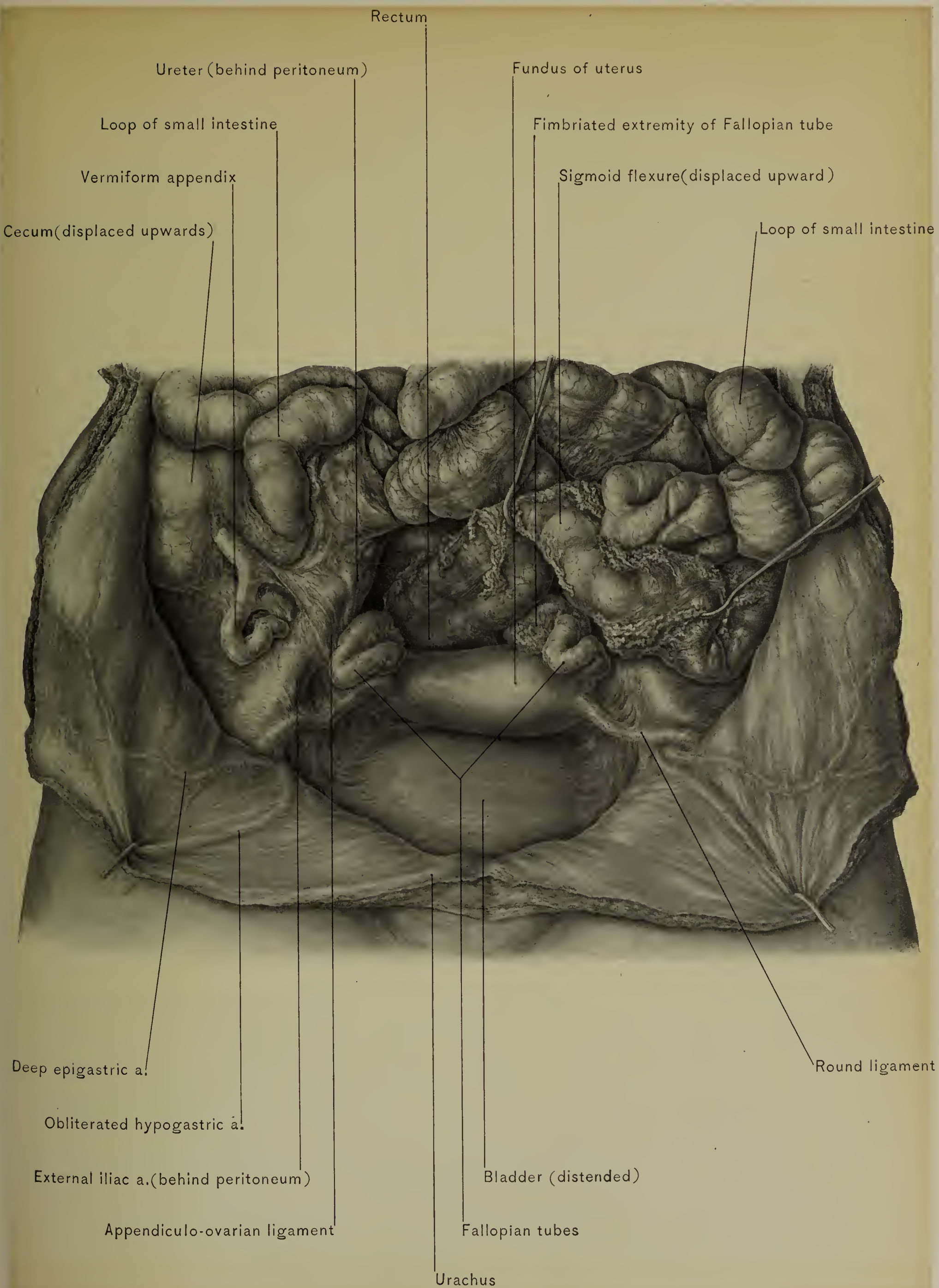
In the female pelvis the cavity between the rectum and bladder (recto-vesical pouch) is subdivided into a recto-vaginal and utero-vesical pouch by the **Uterus**, **Broad Ligaments**, and upper part of the **Vagina**. The **Ovaries** are seen projecting

from the posterior surface of the broad ligaments, and the **Fallopian tubes** are located in the upper or free margin of those ligaments.

In the dissection of the contents of the pelvis the best idea of the relation of the several structures contained therein is most conveniently obtained by an examination of them in the following order: peritoneum, pelvic fascia, blood-vessels, viscera, nerves, muscles, and lymphatics.

The **Peritoneum** in the male, in its descent into the pelvis from the abdominal cavity proper, covers the front and sides of the first portion of the rectum, from which it is reflected to the bladder, covering the posterior wall, the sides, and the summit of this organ. The reflection from the rectum to the bladder forms the **recto-vesical pouch**, the sides of which constitute the **posterior false ligaments of the bladder**, and contain the obliterated hypogastric artery, the vesical arteries, the ureters, and some sympathetic nerves. The pouch is pyramidal in outline, with the base directed upward and the apex downward. The apex of the pouch corresponds to a line connecting the ureters where they enter the bladder-wall. The lowest part of the pouch is ordinarily about three inches from the anus; but it is readily seen how this distance can be increased or lessened by distention or collapse of the rectum and bladder. So far as its relation to the rectum is concerned, it corresponds to the recto-uterine pouch, or Douglas' culdesac in the female.

From the sides of the bladder the peritoneum is reflected to the lateral walls of the pelvis, forming the **lateral false ligaments of the bladder**; and from the summit it is reflected over the urachus and the terminal portion of the obliterated hypogastric arteries to the anterior abdominal walls, forming the **superior false ligament** of the organ. By drawing the bladder well forward and upward the posterior and lateral false ligaments are put on the stretch and thus clearly seen. The superior false ligament is equally well demonstrated by making traction in an upward direction on the anterior parietal peritoneum at the umbilicus. The arrangement of the peritoneum on the bladder affords the surgeon the opportunity of opening the bladder by carrying an incision through the abdominal walls, as in the operation of suprapubic cystotomy, without wounding that membrane. Again, this arrangement of the peritoneum permits of extraperitoneal rupture of the bladder and consequent extraperitoneal urinary extravasation. When **extraperitoneal urinary extravasation** takes place within the abdominal walls, if recognized early, the case may be brought to a favorable issue by opening up the prevesical space, irrigating, and draining it. In extraperitoneal rupture of the bladder, the best possible drainage is obtained by opening the prevesical space, and doing a perineal section to open the membranous urethra as well. The prevesical space is best drained by reaching it above Poupart's ligament and to the outer side of the external iliac vessels.



PELVIC CAVITY OF FEMALE—SUPERIOR VIEW.

In **intraperitoneal rupture of the bladder** an abdominal section and repair of the rent in the bladder are required to prevent a fatal result from peritonitis. If the tear can not be sewed up, the operator can only wash out and drain the peritoneal cavity. Here, again, the chances of avoiding general infection of the peritoneum are improved by making a perineal as well as an abdominal section; thus drainage from below, which is favored by gravity, is secured at the membranous urethra.

In the female, the peritoneum is reflected from the rectum upon the posterior surface of the vagina and uterus. It passes upward to the fundus of the uterus, descends on the anterior surface of that organ to the beginning of the cervix uteri, and is reflected upon the bladder. At the sides of the uterus, the peritoneum turns over the Fallopian tubes and ovaries and doubles upon itself, forming the broad ligaments of the uterus. Thus the intraperitoneal space in the female pelvis is subdivided into two parts by the uterus and broad ligaments. The portion between the rectum and uterus is the recto-vaginal, or Douglas' pouch; and that between the uterus and bladder is the utero-vesical pouch.

DISSECTION.—In order to study the pelvic fascia, the peritoneum must be removed from one side by separating it from the extraperitoneal connective tissue with the finger. The layer covering the same side of the bladder must also be removed. After the peritoneum has been stripped off, a quantity of loose extraperitoneal fatty tissue will be seen. This should be scraped away either with the finger or the handle of the scalpel, great care being taken to keep the fascia intact at the sides of the pelvis, where it is very thin. In the pelvis of the female the structures between the layers of the broad ligament should be preserved.

The **pelvic extraperitoneal connective tissue** is frequently inflamed as a result of inflammation of one of the adjacent pelvic viscera, most commonly of the uterus and Fallopian tubes. The condition is called **pelvic cellulitis**, and tends to abscess formation. These abscesses are usually unable to descend and make an exit in the perineum, because, as seen below, they are unable to pass through the recto-vesical fascia. They must, therefore, ascend; and a large percentage of them open near Poupart's ligament—in the inguinal region.

The **Pelvic Fascia** consists of continuous layers of white fibrous tissue; it lines the pelvic cavity and forms a subserous covering for parts of the pelvic organs and a retentive sheath for others. In front, it is continuous with the transversalis fascia; and on the sides, with the iliac fascia. Superiorly, it is attached to the body of the pubis, to the brim of the pelvis (ilio-pectineal line), and to the innominate bone above the attachment of the internal obturator muscle. It then spreads over the pyriformis muscle as a thin layer which takes the name of the **fascia of the pyriformis**. It is gradually lost over the anterior surface of the

sacrum. Above the obturator internus muscle it bridges a groove on the internal surface of the bone above the obturator foramen and converts it into a canal through which pass the obturator vessels and nerve. Anteriorly, it is attached to the posterior surface of the symphysis pubis. In its descent over the obturator internus muscle, it divides into the obturator and recto-vesical fasciæ. This division is marked by a dense **white line** (*arcus tendineus*), which is on the level of a line drawn from the spine of the ischium to the posterior surface of the body of the pubis, just external to the lower part of the symphysis pubis.

The **obturator fascia** is the outer division and continuation of the pelvic fascia. It extends downward from the white line over the obturator internus muscle and is attached to the innominate bone at the lower margin of the muscle. Above, it is continuous with the pelvic fascia; below, it is attached to the tuberosity of the ischium, and the rami of the pubes and ischium, and the margin of the great sacro-sciatic notch. In front, it is attached to the posterior surface of the pubic bones, in a line drawn downward and inward from the upper anterior part of the obturator foramen to the lower part of the symphysis pubis; and behind, it extends into the gluteal region with the obturator internus muscle through the lesser sacro-sciatic notch. It assists in forming the outer wall of the ischio-rectal fossa and contains Alcock's canal which transmits the internal pudic vessels and nerve. As the obturator is a continuation of the pelvic fascia, and as both fasciæ cover the obturator internus muscle, some authors have described the pelvic fascia as the upper segment of the obturator fascia. The obturator fascia gives off two processes: These are the *superior layer of the triangular ligament* and the *ischio-rectal* or *anal fascia*. If the pelvic fascia is considered as the upper segment of the obturator fascia, the recto-vesical fascia is also a process of the obturator fascia. The superior layer of the triangular ligament is a fascial partition derived from the lower part of the obturator fascia, and passes inward above the compressor urethræ muscle to join the corresponding layer of the opposite side. For further description, see Perineum.

The *ischio-rectal* or *anal fascia*, which lines the perineal surface of the levator ani muscle, is derived from the obturator fascia. Internally, it is lost upon the external sphincter ani muscle; in front, it is continuous with the superior layer of the triangular ligament; and behind, it is continuous with the fascia upon the deep surface of the gluteus maximus muscle.

The **recto-vesical fascia**, the visceral layer of the pelvic fascia, extends downward and inward upon the upper surface of the levator ani muscle. In front of the rectum, the fasciæ of the two sides meet to complete the fascial partition between the perineum and pelvic cavity, thus forming a barrier which hinders the passage of pus or extravasated urine from the perineum to the pelvis.

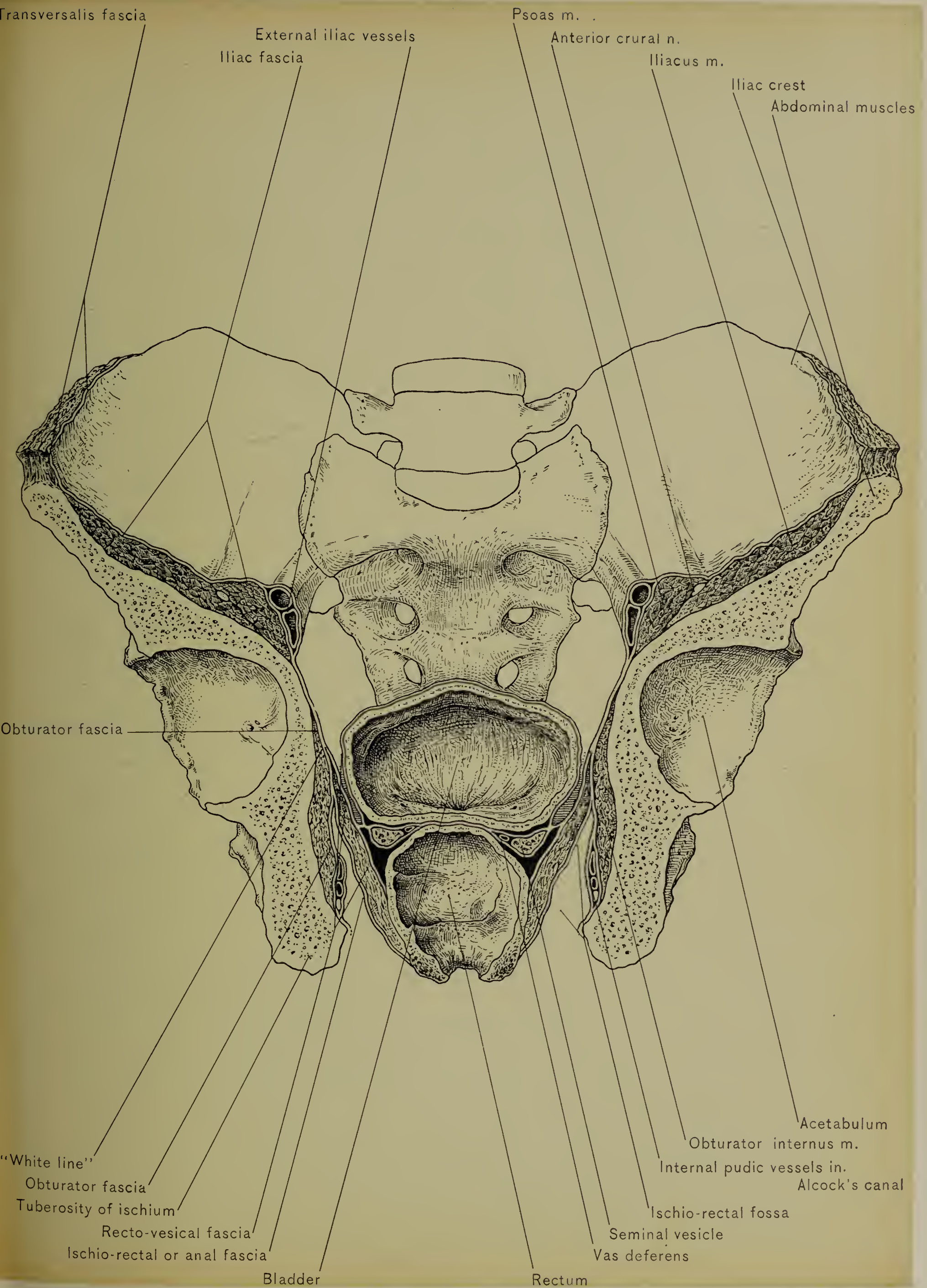
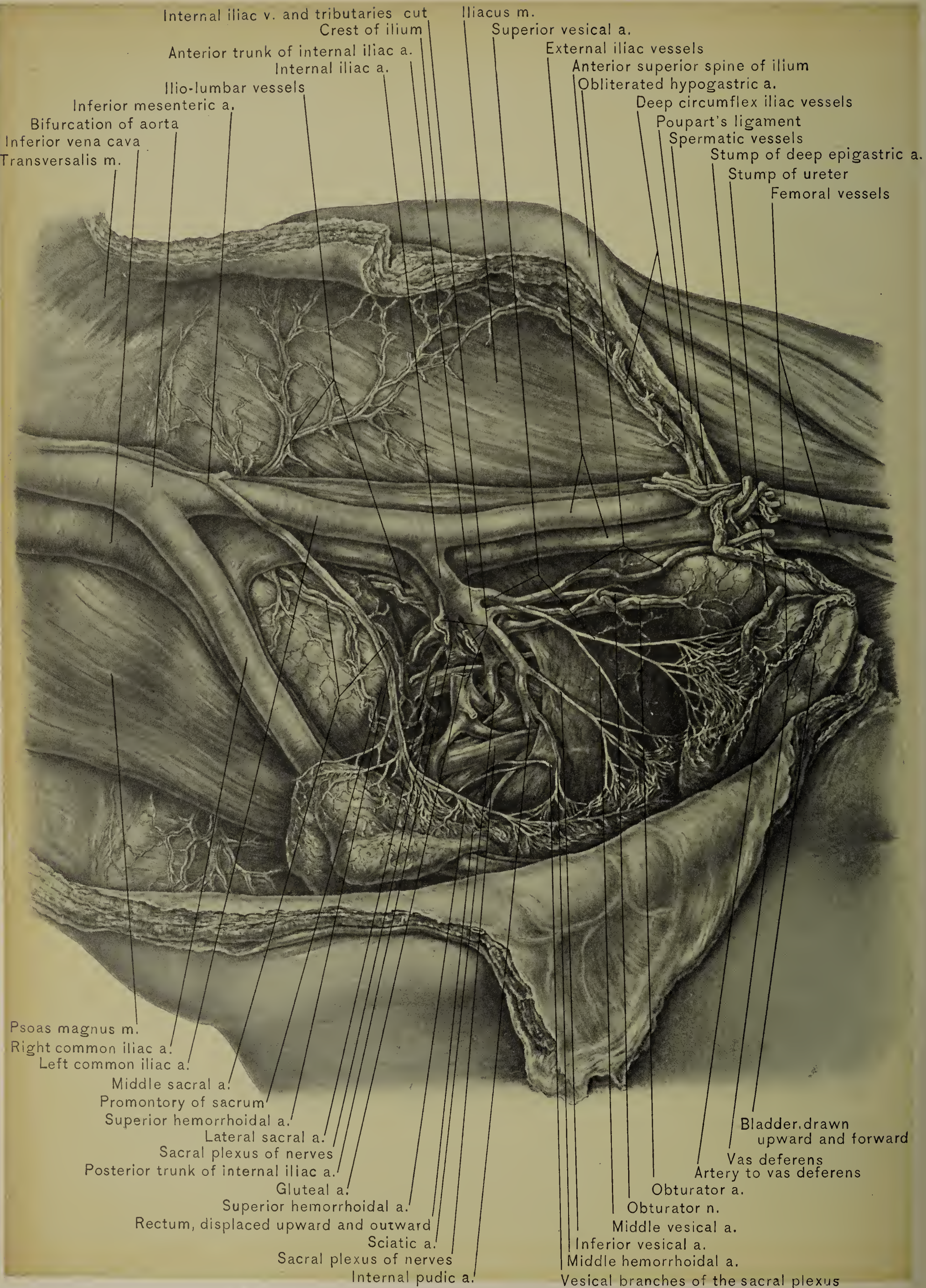


DIAGRAM OF PELVIC FASCIA.



INTERNAL ILIAC ARTERY AND ITS BRANCHES.

In front it is attached to the posterior surface of the pubic bones, above the levator ani muscle and obturator fascia; behind, it is continuous with the fascia of the pyriformis; and externally, it is attached to the pelvic fascia above the origin of the levator ani muscle. Internally, it is continuous with the fibrous coat of the rectum and bladder, and forms the capsule of the prostate; when it reaches the bladder, it divides into two layers. The upper layer forms the fibrous coat of that viscus and the lower surrounds the prostate gland as a capsule, and also covers the seminal vesicles and ejaculatory ducts. At and anterior to the apex of the prostate the recto-vesical fascia and the superior layer of the triangular ligament are so blended as to be inseparable.

The bands of the recto-vesical fascia which pass from the lower part of the pubic bones to the prostate and neck of the bladder are called the *pubo-prostatic* or *anterior true ligaments of the bladder*. The bands of this fascia which pass from the sides of the pelvis to the sides of the bladder are called the *lateral true ligaments* of that organ. The portion of the fascia attached to the rectum has been called the ligament of the rectum.

In the female the recto-vesical fascia is reflected upon the uterus and the vagina and sends a prolongation over the latter.

Arteries of the Pelvis.—The arteries of the false pelvis are the *common* and the *external iliac arteries*. The arteries of the true pelvis are the *internal iliac* and its branches.

The **common iliac arteries** begin at the bifurcation of the aorta and terminate opposite the upper margin of the sacro-iliac synchondrosis by dividing into the external and internal iliac arteries.

The *right common iliac artery* is the longer, owing to the bifurcation of the aorta to the left of the median line. It measures about two inches (five centimeters) in length.

RELATIONS.—In front it is covered with peritoneum, and is crossed by the ovarian artery in the female, the termination of the ileum, sympathetic nerves to the hypogastric plexus, and, just before its bifurcation, by the ureter. Behind it is in relation with the right common iliac vein, the end of the left common iliac vein, and the beginning of the inferior vena cava. On the right side lie the beginning of the inferior vena cava, the termination of the right common iliac vein, and the psoas muscle. On the left side lie the termination of the left common iliac vein, the right common iliac vein, and the hypogastric plexus.

The *left common iliac artery* is one and three-fourths inches (four centimeters) long, a little shorter, but thicker, than the right.

RELATIONS.—In front, the ureter and, in the female, the ovarian artery cross

it near its bifurcation; it is also in relation in front with the sympathetic nerves descending to the hypogastric plexus, the sigmoid flexure, and the meso-sigmoid. Behind it are the bodies of the fourth and fifth lumbar vertebræ, and the intervening cartilaginous disc, the left common iliac vein, and the psoas magnus muscle. To the left is the psoas muscle. To the right are the left common iliac vein, the hypogastric plexus, and the sacral artery.

The common iliac arteries may be absent; in that case the external and internal iliacs arise directly from the aorta; or the common iliacs may be very short (one-half inch = 1.25 centimeters) or very long (four and one-half inches = 11.5 centimeters). The average length is between one inch (2.5 centimeters) and three inches (7.6 centimeters).

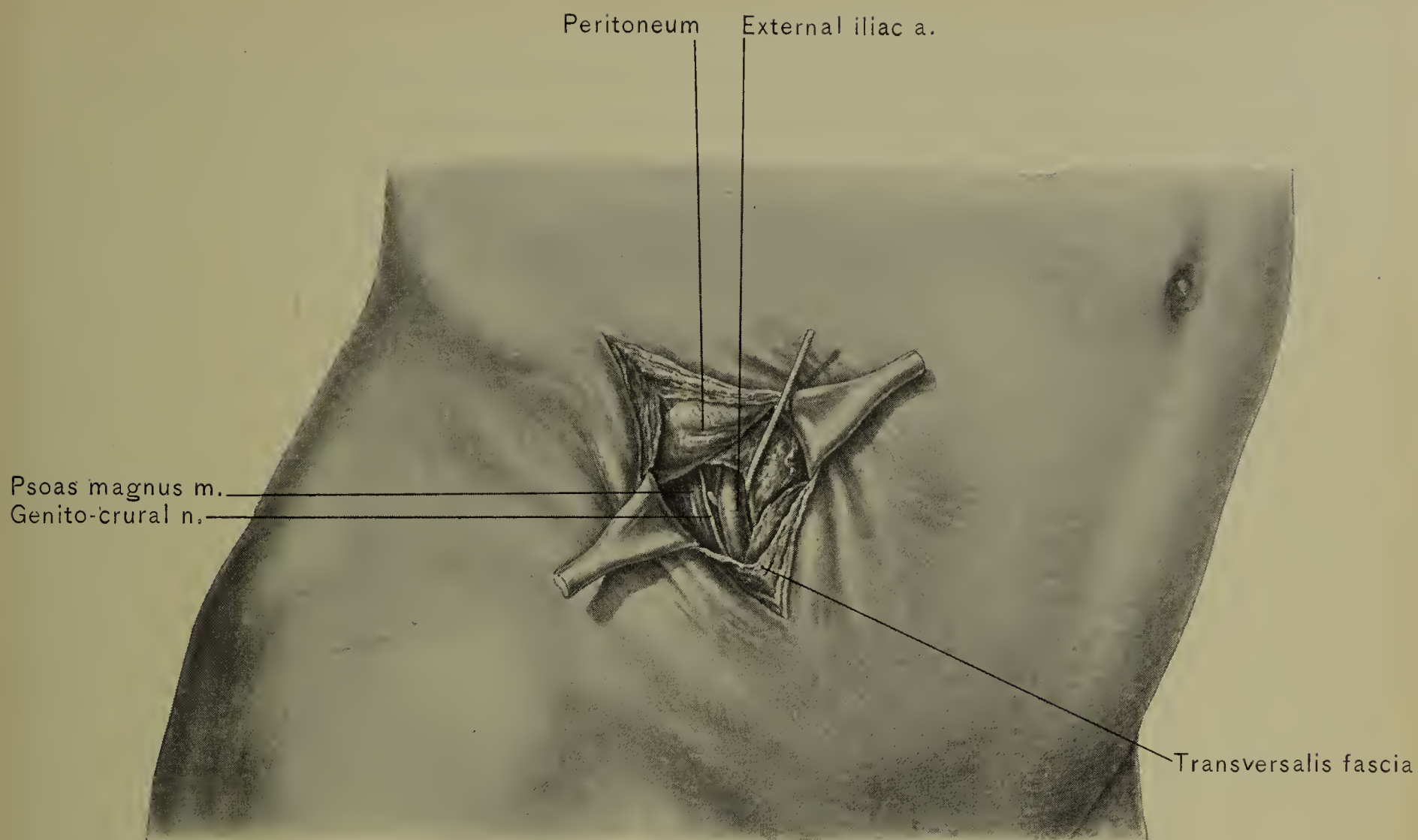
BRANCHES.—The common iliac artery gives off a few small twigs to the peritoneum and extraperitoneal connective tissue, also a few to the ureter. Its terminal divisions are the external and internal iliac arteries.

The left common iliac artery can be more readily ligated, owing to its relations. The operation of ligation may be done either extra- or transperitoneally, the latter method being more commonly employed at the present day. An incision about six inches (fifteen centimeters) in length is made usually in either semilunar line or through either rectus muscle, extending from the level of the umbilicus nearly to the symphysis pubis. The abdomen being opened, the peritoneum covering the artery is incised and the needle passed from within outward on the left side and from without inward on the right, away from the vein. The ureters must be avoided, and on the left side also the superior hemorrhoidal artery.

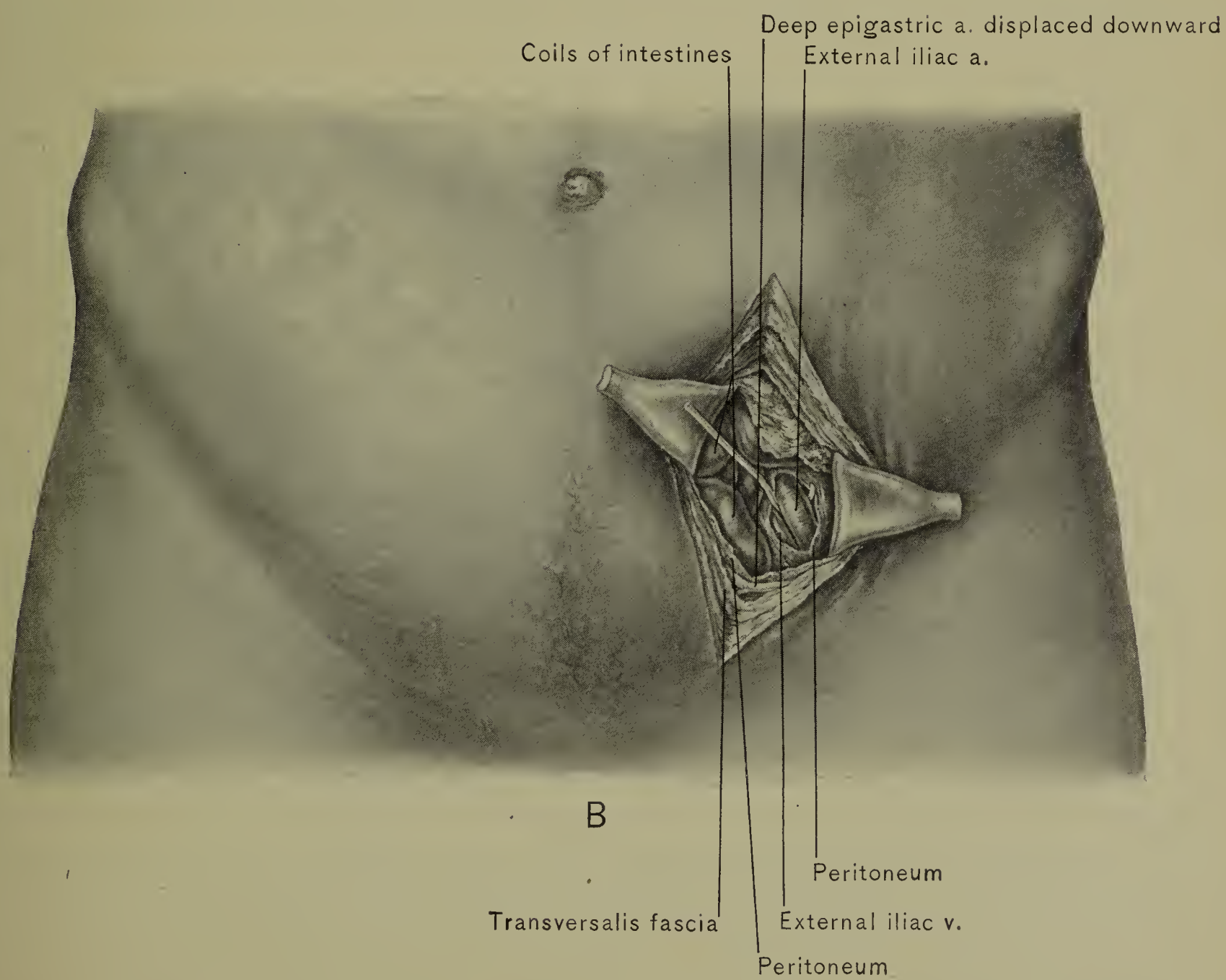
The **collateral circulation** after ligation of the common iliac artery is established by the anastomosis between the lateral and middle sacral arteries; the internal mammary and the deep epigastric; the lumbar branches of the aorta and the ilio-lumbar and deep circumflex iliac; the deep epigastric and obturator by their pubic branches; the hemorrhoidal arteries; the uterine and ovarian arteries; posterior sacral branches and the gluteal; and between the vesical, hemorrhoidal, uterine, vaginal, obturator, and lateral sacral arteries and their fellows of the opposite side.

The **internal iliac artery** may be approached through the same incision and ligated.

The **external iliac artery** is the direct continuation of the common iliac artery. It begins at the bifurcation of the latter at the sacro-iliac synchondrosis and runs along the brim of the true pelvis to Poupart's ligament, terminating at a point midway between the anterior superior spine of the ilium and the symphysis pubis behind Poupart's ligament, where it becomes known as the *femoral artery*.



A



B

LIGATION OF EXTERNAL ILIAC ARTERY.

(A) EXTRAPERITONEAL METHOD. (B) TRANSPERITONEAL METHOD.

The external iliac artery is about three and a half (8.9 centimeters) to four inches (ten centimeters) in length. Its course can be indicated on the surface by drawing a curved line, with its convexity outward, from the bifurcation of the aorta one-half inch (1.3 centimeters) below and to the left of the umbilicus to a point midway between the anterior superior spine of the ilium and the symphysis pubis.

RELATIONS.—Like the common iliac, it lies behind the peritoneum. It is also covered by a condensed portion of extraperitoneal connective tissue, known as Abernethy's fascia. In front it comes in relation with the genital branch of the genito-crural nerve, which crosses the lower third of the artery obliquely; and at its termination with the circumflex iliac vein, which crosses it to empty into the external iliac vein; also at its lower part with the spermatic vessels. The vas deferens and, in the female, the ovarian vessels cross it to gain the cavity of the pelvis; and the ureter sometimes passes in front of it, instead of crossing the common iliac artery. The external iliac lymphatic glands lie along the course of the artery.

Behind, the artery comes in relation with its vein, in the upper part of its course; then with the inner border of the psoas muscle, and lower down, behind Poupart's ligament, with the tendon of the psoas. The iliac fascia lies behind it.

On its inner side are the external iliac vein, the peritoneum, the iliac fascia descending to become the pelvic fascia, the vas deferens in the male, and the ovarian vessels in the female. The right external iliac vein at first lies to the inner side of its artery, but gradually passes behind the latter. On its outer side are the genito-crural nerve, psoas muscle, and the iliac fascia.

The external iliac artery may vary somewhat in length. It may be either shorter or longer than normal, depending upon the low or high bifurcation of the common iliac artery. When long, a loop of it may extend into the cavity of the pelvis. It may also be smaller in size than normal, especially when the femoral arises from some branch of the internal iliac artery, usually the sciatic artery, in which case it may end in the profunda femoris.

The branches of the external iliac artery are the deep epigastric, the circumflex iliac artery, and a few small branches to the psoas muscle and lymphatic glands.

The **deep epigastric artery** arises from the external iliac artery, as a rule close to Poupart's ligament, but may arise several inches higher up; or it may even arise from the femoral below Poupart's ligament, and sometimes from the profunda femoris artery. It frequently gives off the circumflex iliac artery, or the

obturator artery ; and occasionally it arises from the obturator artery. Sometimes it is found to be double.

This artery has been described with the structures of the abdominal wall.

The **deep circumflex iliac artery** arises from the outer side of the external iliac artery close to Poupart's ligament and passes outward and upward to the anterior superior iliac spine between the transversalis fascia and peritoneum, or in a sheath-like canal formed by the junction of the transversalis and iliac fasciæ. It perforates the transversalis fascia and the transversalis muscle near the anterior superior iliac spine and then runs between the transversalis and internal oblique muscles, along the crest of the ilium, dividing into an ascending branch which anastomoses with the lumbar and intercostal arteries, and an iliac or marginal branch which anastomoses with the ilio-lumbar artery.

The deep circumflex iliac artery may arise in common with the deep epigastric or rarely from the femoral. Like the epigastric, it may be given off higher up than normal, but generally a little below that vessel, or it may be double.

The companion veins of this artery usually empty by a single trunk, which crosses the lower portion of the external iliac artery, into the external iliac vein, but may join the deep epigastric vein.

The **internal iliac artery** is short, thick, and smaller than the external iliac. It is one to one and a half inches (two and one-half to four centimeters) in length, and arises as one of the two terminal branches of the common iliac artery, at the upper margin of the sacro-iliac synchondrosis. It descends into the pelvis, in the extraperitoneal fat, and just above the upper margin of the great sacro-sciatic notch divides into an anterior and a posterior branch. It is interesting to know that the combined length of the common and internal iliac arteries is uniform, so that the greater length of one entails shortening of the other.

RELATIONS.—It rests behind upon the internal iliac vein, the lumbo-sacral cord, and the pyriformis muscle ; is crossed on its inner side by the ureter, and covered by peritoneum ; the psoas magnus muscle and termination of the external iliac vein lie upon its outer side.

During fetal life the internal iliac is much larger than the external, and appears to be the direct continuation of the common iliac. It does not dip into the pelvis, but passes to the bladder and along its side to the summit, from which it extends along the anterior wall of the abdomen to the umbilicus, through which it passes. While within the abdominal cavity the vessel is known as the *hypogastric artery* ; after passing through the umbilicus, it is called the *umbilical artery*. The umbilical arteries wind around the umbilical vein, helping to form the umbilical cord, and are distributed to the placenta. After the placental circulation has

ceased, all but a short portion of the lower end of the hypogastric artery becomes obliterated. The proximal end becomes greatly reduced in size and forms the root of the superior vesical artery.

The *anterior trunk of the internal iliac artery* gives off the superior and inferior vesical, uterine, vaginal, middle hemorrhoidal, obturator, internal pudic, and sciatic arteries.

The *posterior trunk of the internal iliac artery*, shortly after the bifurcation of the parent stem, gives off, from its posterior surface, an ascending branch, the *ilio-lumbar*; and, below this, the two *lateral sacral arteries*. It then emerges from the pelvis as the *gluteal artery*.

The **superior vesical artery** begins as a trunk which is large in proportion to the branches given off. This portion of the artery is the patulous part of the hypogastric artery, which, even in the adult, appears to be the continuation of the trunk of the internal iliac. It supplies the summit and upper part of the bladder. It gives off a branch to the vas deferens, known as the *artery of the vas deferens*; twigs to the urachus and ureter; and its most posterior branch, the *middle vesical artery*, descends to the base of the bladder and adjacent under-surface of the seminal vesicle. This latter vessel may be given off from the unobliterated trunk of the hypogastric artery instead.

The **inferior vesical and the middle hemorrhoidal arteries** frequently arise by a common trunk from the anterior trunk of the internal iliac. The **inferior vesical artery** goes to the base of the bladder, the seminal vesicle, and the prostate, the last inosculating with the prostatic branches of the other side. When one of these prostatic branches is of large size and supplies parts normally supplied by the internal pudic, it is known as an accessory pudic artery. In the female the inferior vesical artery gives off vaginal branches. The artery to the vas deferens may arise from the inferior instead of the superior vesical artery. The **middle hemorrhoidal artery** goes to the rectum, there anastomosing above with the superior hemorrhoidal from the inferior mesenteric, and below with the inferior hemorrhoidal from the internal pudic artery.

The **uterine artery** arises from the anterior division of the internal iliac just below or in common with the middle hemorrhoidal, and passes downward and inward toward the cervix uteri. It crosses in front of the ureter, one-third to three-fifths of an inch (one to one and one-half centimeters) from the cervix uteri. It then turns upward, and ascends in a tortuous manner between the layers of the broad ligament and on the side of the uterus. It sends numerous branches at a right angle to its course to spread over both surfaces of the uterus in a tortuous manner; and anastomoses with the uterine branch of the ovarian artery. The *cervical branch* of the uterine artery springs from that vessel as it crosses the

ureter. It passes directly inward and divides into four or five branches, one of which anastomoses with the cervical artery of the opposite side so as to form the *circular artery of the cervix*. Other branches anastomose with branches of the vaginal to form the azygos arteries of the vagina, which run along the median line of the vaginal wall, one lying in front and the other behind. In hysterectomy the uterine artery should be tied less than one-third of an inch (one centimeter) from the cervix to avoid the ureter.

The **vaginal arteries** arise from the internal iliac, although one or more of them may arise in common with the uterine, inferior vesical, or middle hemorrhoidal artery. As a rule, there are but two; but there may be three, or even four. They pass to the sides of the vagina to supply its walls, and then anastomose with each other, with branches from the other side, and with branches of the uterine artery. The anastomoses with the branches of the uterine artery form two vertical trunks along the median line of the vagina, one of which is upon its anterior, and the other upon its posterior, wall. These are known as the *azygos arteries of the vagina*. The lowermost branches extend to the vestibule, where they communicate with the bulbal branch of the internal pudic. Small branches from the vaginal arteries pass to the rectum.

The **obturator artery** arises from the anterior trunk of the internal iliac, though it may be a branch of the posterior trunk. It runs directly forward along the lateral wall of the pelvis below its brim to the upper part of the obturator foramen, through which it passes in company with its vein and the obturator nerve. It lies between the obturator nerve which is above it, and the vein which is below it. Like the other branches of the internal iliac, it runs in the extraperitoneal fat—between the peritoneum and the fascia. It passes out of the pelvis through an opening at the upper part of the obturator foramen caused by a deficiency in the obturator membrane at that point, usually passing over the upper border of the pelvic fascia and not, as a rule, piercing it, as the other arteries do, in order to pass out of the pelvis. The nerves, however, lie on the outside of the pelvic fascia, and therefore do not pierce the fascia. Just before reaching the foramen the obturator vessels and nerve lie in the **obturator canal** which is formed by the pelvic fascia bridging over the groove in the internal surface of the horizontal ramus of the pubic bone. At this point it is crossed by the vas deferens. Through this canal an obturator hernia may pass and not carry the pelvic fascia, obturator internus muscle, or obturator membrane with it. In the pelvis the obturator artery gives off *iliac, vesical, and pubic branches*. Just outside of the pelvis it divides into an *external* and an *internal branch*. The *iliac branch* is a nutrient artery to the ilium, supplies the psoas and iliacus muscles, and anastomoses with the ilio-lumbar artery. The *vesical branches* supply the bladder. The *pubic branch*



UTERUS, BROAD LIGAMENT, UTERINE ARTERY, AND URETER.

passes upward behind the pubis, anastomoses with the pubic branch of the deep epigastric artery and with the pubic branch of the obturator artery of the other side, and supplies the adjacent structures. Outside of the pelvis the obturator artery divides into an *external* and an *internal branch* which form a circle on the outer surface of the obturator membrane and are described with the lower extremity. In one out of three cases the obturator artery arises from the deep epigastric; occasionally, from both the deep epigastric and internal iliac; and, rarely, from the external iliac just before it passes under Poupart's ligament to become the femoral. When it arises from the deep epigastric artery, it may pass above and to the inner side of the femoral ring, so that it might be cut by a deep incision made for the relief of a constriction in femoral hernia. Usually a small artery is then given off from the anterior trunk of the internal iliac, taking the usual course of the obturator artery. This is more fully treated in the description of the thigh under femoral hernia, to which the reader is referred.

The **internal pudic artery**, the smaller of the two terminal branches of the anterior trunk of the internal iliac artery, passes downward and outward to leave the pelvis at the lower margin of the greater sacro-sciatic foramen, where it pierces the fascia and passes between the pyriformis and coccygeus muscles. It then crosses the outer surface of the spine of the ischium with its accompanying nerve and vein, under cover of the gluteus maximus muscle, and reenters the pelvis through the lesser sacro-sciatic foramen. With the vein and nerve, it crosses the obturator internus muscle, then lies in the outer wall of the ischio-rectal fossa, and passes forward in Alcock's canal in the obturator fascia. The artery continues forward in this canal and over the obturator internus muscle to the ramus of the ischium. It pierces the deep layer of the triangular ligament of the urethra and then runs upward and forward along the pubic arch in the substance of the compressor urethræ muscle. Between the layers of the triangular ligament it gives off the artery of the bulb and the artery of the corpus cavernosum, and then pierces the superficial or anterior layer of the triangular ligament as the dorsal artery of the penis. The artery of the bulb passes inward and slightly upward in the substance of the compressor urethræ muscle, and upon reaching the urethra passes through an opening in the anterior or superficial layer of the triangular ligament to be distributed to the bulb and corpus spongiosum. This artery should be avoided in the operation of lateral lithotomy. It is usually one-half of an inch (one centimeter) above the central tendon of the perineum. The artery of the corpus spongiosum is given off higher up than the artery of the bulb; it runs along the ramus of the pubes, perforates the superficial layer of the triangular ligament near the subpubic ligament, and then enters the crus penis. In the female the artery ends in the crus clitoridis. The dorsal artery of the penis is the continu-

ation of the internal pudic and also pierces the anterior or superficial layer of the triangular ligament close to the subpubic ligament. It then passes between the two layers of the suspensory ligament of the penis, the single centrally placed vein separating it from the artery of the opposite side. The dorsal nerve of the penis lies on its outer side, and still further externally lies the deep external pudic branch of the common femoral artery. At the glans the two dorsal arteries anastomose to encircle the corona. In the female the termination of the internal pudic artery is called the dorsal artery of the clitoris.

RELATIONS.—At first the internal pudic artery lies in front of the pyriformis muscle and the sacral plexus, and external to the rectum. It is covered by the gluteus maximus muscle and the great sacro-sciatic ligament as it crosses the spine of the ischium, and may be felt pulsating at this point in a thin subject. This point may be located by taking the spot at the junction of the inner with the outer two-thirds of a line drawn from the top of the great trochanter rotated inward, to the base of the coccyx. Next, it lies in a fibrous canal (Alcock's canal) formed by the obturator fascia and the falciform process of the great sacro-sciatic ligament; and rests in that fascia against the internal surface of the obturator internus muscle, which assists in forming the outer wall of the ischio-rectal fossa. Accompanying it are its venæ comites and the pudic nerve. Within the pelvis, and upon the spine of the ischium, it gives off some twigs to the adjacent muscles. In the perineum its branches are *muscular* to the obturator internus muscle, the *inferior hemorrhoidal*, *superficial perineal*, *transverse perineal*, *artery of the bulb*, *artery of the corpus cavernosum*, and *dorsal artery of the penis*. These are described with the perineum.

The **sciatic artery**, the larger of the two terminal branches of the anterior trunk of the internal iliac, descends behind the internal pudic artery, pierces the pelvic fascia, and leaves the pelvis through the lower part of the greater sacro-sciatic foramen, lying behind and external to the internal pudic artery. Within the pelvis it lies upon the pyriformis muscle and the sacral plexus, and gives off branches to the pyriformis, coccygeus, and levator ani muscles, to the rectum, and to the base and neck of the bladder, the seminal vesicles, and the prostate gland. In the gluteal region it descends upon the obturator internus tendon and gemelli muscles. It is a short trunk, and gives off, in this region, the coccygeal, muscular, inferior gluteal, articular, anastomotic, cutaneous, and *arteria comes nervi ischiatici*. These branches are described with the gluteal region.

The **ilio-lumbar artery** is derived from the posterior trunk of the internal iliac and passes upward and outward beneath the psoas magnus muscle and external iliac vessels, lying close to the pelvic wall. It runs beneath the iliacus muscle to the upper part of the iliac fossa, where it divides into an iliac and a lumbar branch. The *iliac branch* supplies the iliacus muscle, and enters an

oblique nutrient canal of the ilium to supply that bone. Other branches pass along the iliac crest to supply the adjacent portions of the abdominal and gluteal muscles, and anastomose with the circumflex iliac, external circumflex, and epigastric arteries. The *lumbar branch* ascends to supply the psoas magnus and quadratus lumborum muscles, sends a small spinal branch through the lumbo-sacral intervertebral foramen to the spinal cord and its meninges, and anastomoses with the last lumbar artery.

The **lateral sacral arteries** are usually two in number, a superior and an inferior. The *superior lateral sacral artery* passes downward and inward, anastomosing with branches of the middle sacral arteries, to the first anterior sacral foramen which it enters to supply the cauda equina and spinal membranes, and emerges on the back at the upper posterior sacral foramen, to supply the skin and muscles over the sacrum, anastomosing in that locality with the gluteal artery. The *inferior lateral sacral artery* passes inward across the first sacral nerve and the piriformis muscle and then downward upon the front of the sacrum along the inner side of the anterior sacral foramina and external to the sacral sympathetic ganglia. In front of the coccyx it anastomoses with branches of the middle sacral and the lateral sacral arteries of the opposite side. It gives off larger branches which enter the anterior sacral foramina and anastomose with the lateral and anterior spinal arteries. They then emerge from the posterior sacral foramina to be distributed to the skin and muscles over the sacrum, anastomosing with branches from the gluteal artery. The lateral sacral arteries supply branches to the piriformis and coccygeus muscles, to the sacral plexus, and to the rectum, and larger branches to the contents of the spinal canal. Internal branches anastomose with the middle sacral artery.

The **gluteal artery**, the continuation of the posterior trunk of the internal iliac, and the largest branch of the internal iliac, is short and thick. Passing backward, it runs between the first sacral nerve and the lumbo-sacral cord through an osseo-tendinous arch formed by the margin of the bone and the upper edge of the pelvic fascia. In company with its venæ comites and the superior gluteal nerve, it leaves the pelvis, at the upper part of the greater sacro-sciatic foramen and above the piriformis muscle, to supply the buttock. Within the pelvis it sends muscular branches to the coccygeus, piriformis, levator ani, and obturator internus muscles, and a nutrient artery to the innominate bone just before its exit from the pelvis. Outside the pelvis it divides into a superficial and a deep branch which are described with the gluteal region.

The gluteal artery, as well as the sciatic and internal pudic arteries, may require ligation for wounds or aneurysm. The surface lines of these arteries and

the surface markings of the points of exit of these vessels from the pelvis are described with the gluteal region.

Veins of the Pelvis.—The veins of the false pelvis are the *common iliac* and the *external iliac veins*. The veins of the true pelvis are the *internal iliac* and its tributaries, and the *hemorrhoidal* and *vesico-prostatic plexuses* in the male, and the *vaginal* and *uterine plexuses* in the female. The latter empty into the internal iliac vein by the *venæ comites* of branches of the internal iliac artery.

The **common iliac veins** are formed by the external and internal iliac veins and their tributaries. They differ in their relations to the corresponding arteries on the two sides of the body. The *left common iliac vein* is in relation to both arteries, since it crosses from its position below and to the right side of the left common iliac artery to the right side of the spinal column, where it lies behind the right common iliac artery and joins the right common iliac vein to form the inferior vena cava. The *right common iliac vein* ascends behind its companion artery, but gradually passes toward the right side of the latter to join the vein of the opposite side to form the inferior vena cava.

The **external iliac vein** is the continuation upward of the common femoral vein. It begins at Poupart's ligament and ends at its junction with the internal iliac to form the common iliac vein at the sacro-iliac synchondrosis. The left lies to the inner side of its companion artery throughout its course, whereas the right at first lies internal to its artery and then behind it. The deep circumflex iliac vein and the deep epigastric veins empty into it a little above Poupart's ligament.

The **internal iliac vein** is formed by tributaries which hold the same course as the branches of the internal iliac artery, with the exception that it receives no vein which corresponds to the obliterated hypogastric artery. It receives blood from the exterior of the pelvis; and also from the organs in the cavity of the pelvis through the hemorrhoidal and vesico-prostatic plexuses in the male, and through the vaginal and uterine plexuses in the female. The internal iliac vein terminates opposite the sacro-iliac articulation, where it unites with the external iliac vein to form the common iliac vein. In its course it lies at first on the inner side of, and then behind, the internal iliac artery. It contains no valves.

Growths, or the pregnant uterus, may cause obstruction of the circulation in the veins of the pelvis; or septic emboli may cause thrombosis and phlebitis of these veins; or the veins may be the seat of primary phlebitis. Obstruction in the internal iliac vein or its tributaries in the female, either through pressure, as by the gravid womb, or by thrombosis, may cause varicose veins in the vagina or vulva, or edema of the vulva. The external iliac vein may likewise be pressed upon by pelvic growths or the pregnant uterus; or it may be the seat

of phlebitis, or thrombosis, as in phlegmasia alba dolens after child-birth, conditions which cause edema of the lower extremity.

The veins forming the various plexuses in the pelvis are noted for their great tortuosity. They also have very frequent anastomoses.

The **vesico-prostatic plexus of veins** is found surrounding the neck and base of the bladder and the prostate gland. It receives the dorsal vein of the penis and the veins from the vesical venous plexus, and communicates behind with the hemorrhoidal plexus. Its veins are of large size, and in old men may become varicose and contain phleboliths or vein-stones. It empties into the internal iliac by means of a single vein.

The **vesical plexus** surrounds the fundus, sides, and anterior and posterior surfaces of the bladder and empties into the vesico-prostatic plexus.

The **uterine plexus of veins** is formed by large veins from the uterus. It is situated along the sides and superior angles of the uterus. Unlike the uterine arteries, the veins do not hold a tortuous course. They anastomose frequently with themselves and with the ovarian veins. The blood from the uterine plexus of veins returns partly through the ovarian veins and partly by the uterine veins which accompany the uterine arteries.

The **vaginal plexus of veins** is found in the mucous and muscular coats of the vagina, being especially marked near the vaginal orifice. It communicates with the hemorrhoidal plexus behind, and with the vesical plexus in front, and is drained by the vaginal veins which empty into the internal iliac veins.

The **dorsal vein of the penis** is an exception to the rule that the veins of the pelvis follow the same general course as the arteries. It pierces the two layers of the triangular ligament and divides into two branches which communicate with the internal pudic and obturator veins, and enter the vesico-prostatic venous plexus instead of the internal pudic veins.

The **pudic veins** begin at the corpus cavernosum, with the vein issuing from that body alongside the artery, and communicate with the dorsal vein of the penis.

The **ilio-lumbar and middle sacral veins** usually empty into the common iliac vein.

The **hemorrhoidal plexus of veins** surrounds the lower part of the rectum and is situated between the mucous and muscular coats. Its blood is distributed to the internal pudic vein through the inferior hemorrhoidal, to the internal iliac vein through the middle hemorrhoidal, and to the inferior mesenteric and portal veins through the superior hemorrhoidal vein. This plexus, therefore, is a link between the systemic and portal systems of veins, and explains the occurrence of piles (hemorrhoids) in obstruction of the portal vein, as in cirrhosis of the liver, as well

as in obstruction of the local systemic veins, as by pelvic tumors and the pregnant uterus. The veins of this plexus are destitute of valves.

The **Viscera of the Pelvis** comprise the rectum, the bladder, and the lower portion of the ureters in both sexes; the uterus, ovaries, and vagina, and their adnexa, in the female; and the prostate, seminal vesicles, and vasa deferentia in the male.

The **rectum** is the terminal portion of the large bowel. It begins at the lower end of the sigmoid flexure at the third sacral vertebra and opposite the greater sacro-sciatic foramen (see description of sigmoid flexure). It ends at the anus a short distance in front of the tip of the coccyx. It is about five inches (12.5 centimeters) in length, and of varying diameter in its different parts. It is described as composed of two parts, an upper and a lower, which correspond to the second and third portions of the rectum in the old descriptions.

The *first or upper portion of the rectum* is three or three and one-half inches (7.5 or 8.5 centimeters) in length and is the most dilated portion of the rectum. It lies upon the front of the sacrum and extends downward from the third sacral vertebra to about one inch (2.5 centimeters) in front of the tip of the coccyx, at which point the rectum bends backward, the angle thus formed marking the division between the two portions of the rectum. The upper two-thirds of the upper portion lie in the sacro-coccygeal hollow, and this portion of the gut is correspondingly curved, convex posteriorly and concave anteriorly, while its lower third rests against the musculo-fibrous structure situated between the coccyx and anus, called by Symington the *ano-coccygeal body*. Just above the junction of the first with the second portion the bowel is dilated, and forms the *ampulla of the rectum*. The upper portion of the rectum is in relation in front with the peritoneum, bladder, seminal vesicles, vasa deferentia, and prostate in the male, and vagina in the female.

The *second or lower portion of the rectum*, termed by Symington the *anal canal*, is one and one-half or two inches (four or five centimeters) in length, and begins at about the apex of the prostate or the tip of the coccyx, whence it passes downward and backward to the anus. It is encircled throughout almost its entire extent by the internal sphincter ani muscle which permits its walls to separate only during the passage of feces. The external sphincter guards its orifice, the anus. Above the outer sphincter is the levator ani muscle which supports the bowel. Because of the recession of the anal canal, an angular interval separates the lower end of the rectum from the urethra and bulb of the penis. This portion of the rectum has no peritoneal covering.

The *walls of the rectum* are serous, fibrous, muscular, submucous, and mucous.

The *serous or peritoneal coat* covers the front and sides of the first portion.

The lower limit of the peritoneal covering on the posterior surface of the bowel is at the commencement of the rectum, opposite the third sacral vertebra and about five inches (12.5 centimeters) from the anus. This limit inclines downward as the anterior surface of the rectum is approached. On this surface the lowest limit of the peritoneum is about three inches (7.5 centimeters) from the anus, when the bladder is partly distended; it may be reduced to two and one-half inches (six centimeters) when the bladder is empty, and may be increased to four inches (ten centimeters) in full distention of the bladder. In the male this covering is reflected upon the bladder, thus forming the *recto-vesical pouch*; in the female, upon the vagina, forming the *recto-vaginal pouch*, or *culdesac of Douglas*.

The *fibrous coat* is delicate and is derived from the recto-vesical fascia.

The *muscular coat* is composed of an external longitudinal and an internal circular layer. The longitudinal layer is most marked upon the anterior and posterior walls, but is not arranged in bands. Some of the longitudinal fibers are attached to the coccyx, and form a *recto-coccygeal muscle*. The circular fibers are most numerous in the second or terminal portion of the rectum, where they form the *internal sphincter ani muscle*.

The *submucous coat* is composed of rather lax areolar tissue, which is especially loose in children, and at times permits prolapse of the mucous coat. As in other portions of the intestine, the submucous layer contains the vessels and nerves which supply the mucous and muscular layers. The *veins of the rectum* in this layer communicate with the portal venous system through the superior hemorrhoidal tributary of the inferior mesenteric vein, and with the systemic circulation through the middle and inferior hemorrhoidal veins which are tributaries of the internal iliac vein. The dependent position of these vessels, and their liability to pressure from hardened feces and disturbances in the portal and systemic circulations, explains the frequency of a varicose condition of these veins, with the formation of piles, or hemorrhoids. The *arteries of the rectum* form a plexus in this layer; they are derived from the superior, middle, and inferior hemorrhoidal arteries.

The *mucous coat* is of a reddish color and is thicker and more vascular than in the colon. In the first portion of the rectum and lower end of the sigmoid flexure it forms three or more oblique or transverse folds (*plicæ recti*), described by Houston, which are situated upon the front and sides of the bowel. The largest of these folds is situated on the right side of the gut, about on a level with the line of reflection of the peritoneum from the bladder to the rectum. As a rule, there are two other folds—one about one inch (2.5 centimeters) above the large fold and the other about the same distance below it; they project from the left side of the gut. The *plicæ recti* can be seen during life by placing the patient in the knee-

chest position, and, with the proper instruments, distending the rectum and allowing air to enter. These folds may hinder the introduction of a bougie or rubber tube.

Through the rectum, in the male, Cowper's glands (when inflamed), the prostate gland, the base of the bladder, the seminal vesicles, the spermatic ducts, and the contents of the recto-vesical pouch may be palpated. When an inflamed vermiform appendix projects downward into the pelvis, it may be felt through the rectum. Through the rectum, in the female, the uterus, ovaries, Fallopian tubes, and contents of the recto-vaginal pouch may be felt. As in the male, an inflamed appendix extending into the pelvis may also be felt through the rectum.

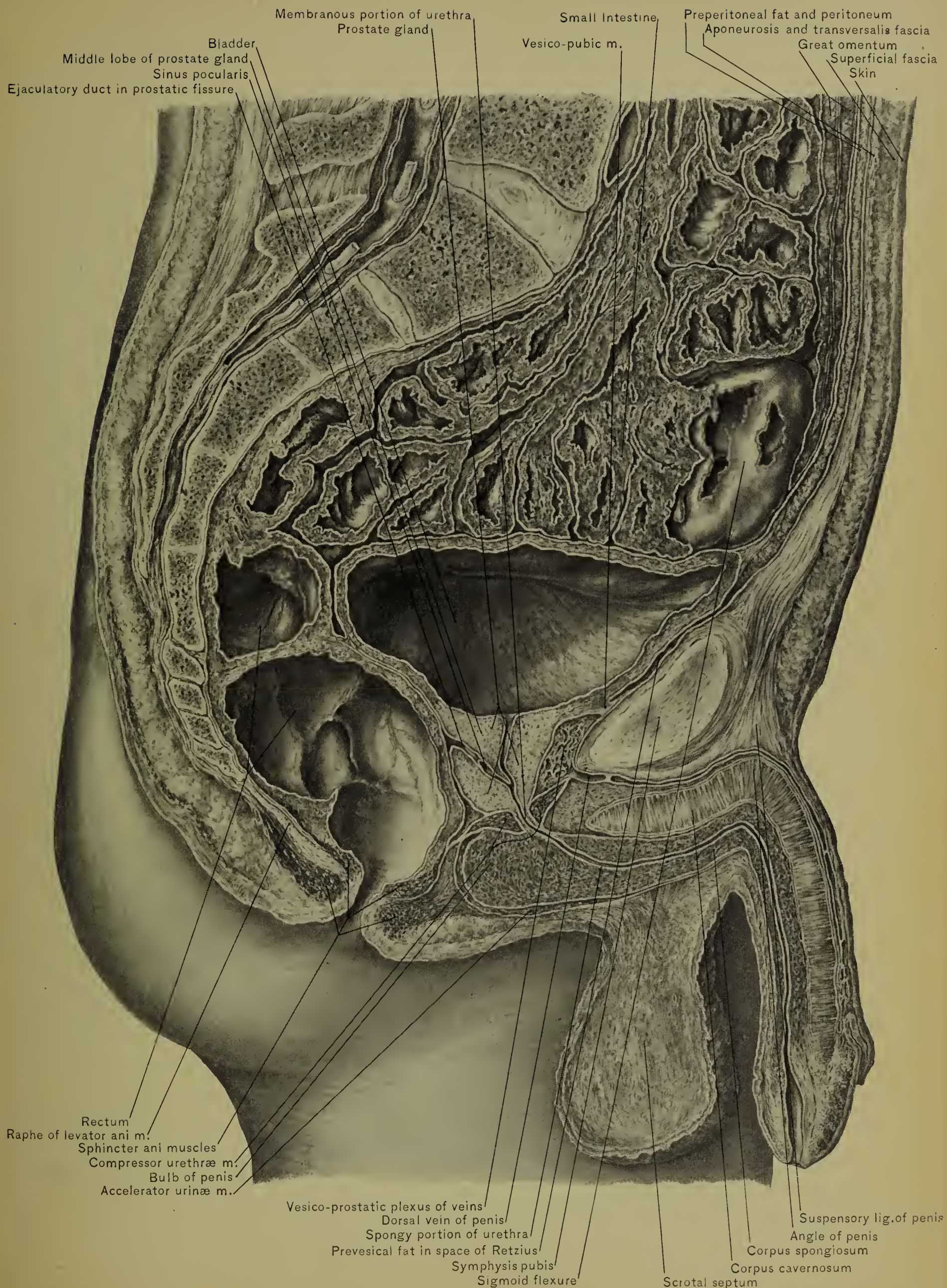
Imperforate rectum consists in congenital occlusion of the anal canal, though the anus may be normal. If feces are not passed within a few hours after birth, suspicion of this defect should always arise, and an examination should be made with the little finger. Sometimes, in these conditions, the bowel opens into the bladder, in which event the meconium passed by the new-born infant would be found upon the front of the diaper and upon the penis. The remedy for imperforate rectum is the establishment of an artificial anal canal.

The **Bladder** is a hollow, fibro-muscular viscus, which is the urinary reservoir, situated in the pelvis above the urethra, the prostate, the triangular ligament of the urethra, and the levator ani muscle. When empty, the bladder is almost entirely within the pelvis; but if distended, it ascends into the abdominal cavity behind the recti muscles, and may extend as high as the umbilicus. The shape of the organ usually varies with the age of the person, being longer and narrower in the infant than in the adult. This fact is due to development of the viscus from the allantoic duct of fetal life, the bladder being the lower unobliterated portion of that fetal structure the upper portion of which atrophies and remains as the **urachus**, which is found as a fibrous cord running from the summit of the bladder to the umbilicus. The long, narrow bladder of the infant projects above the crest of the pubis even when empty, a fact to be borne in mind when operating upon this organ in children.

The adult bladder when moderately distended measures about five inches (12.5 centimeters) in its long axis and about three inches (7.5 centimeters) in its transverse diameter. Its average capacity is about a pint (0.5 liter), but this varies with the age and habits of the individual. In the female, the bladder is greater in its transverse than in its vertical diameter, and is said to have a greater capacity.

The distended bladder is divided into a summit or apex, a body, a base or fundus, and a neck or cervix.

The **summit of the bladder** is directed forward and upward. It is rounded



MALE PELVIS AND PERINEUM—SAGITTAL SECTION.

in form, and is connected with the umbilicus by the *urachus*, the obliterated portion of the allantoic stalk of fetal life. In front of this fibrous cord the summit of the bladder is devoid of peritoneum, which in distention of the bladder is carried upward by the urachus.

The **body of the bladder** is in contact, in front, with the puboprostatic ligaments, the symphysis pubis, the bodies of the pubic bones, and, when distended, with the anterior abdominal wall. The anterior surface is free from peritoneal covering. The anterior and lateral surfaces of the bladder, which are not covered with peritoneum, are loosely united to the adjacent structures by areolar and fatty tissues containing numerous veins. This prevesical areolar tissue and fat is continuous with the extraperitoneal areolar tissue.

Distention and movements of the bladder are favored by these loose connections. The space which this loose areolar tissue occupies is known as the *space of Retzius*, or *cavum prævesicale*. Posteriorly, the body of the bladder is covered with peritoneum, and is in relation, in the male with the rectum, in the female with the uterus, and in both sexes with the small intestine and sigmoid flexure, which gravitate to the pelvis. The *sides* of the body of the organ are crossed obliquely upward and forward by the obliterated hypogastric arteries. Above and behind these arteries the body of the bladder is covered by peritoneum, but in front of and below them, the bladder rests against the pelvic and transversalis fascias, and is free from peritoneum. Crossing the hypogastric arteries will be seen the vasa deferentia which pass along the sides of the body of the bladder. In passing downward in the pelvis the vasa deferentia run between the ureter and the bladder and then along the inner sides of the ureters.

The **base, fundus, or bas fond of the bladder** faces downward and backward. It is broad and flat when the bladder is distended, but becomes narrower when empty. In the male it rests against the upper portion of the rectum, from which it is separated by areolar tissue. At the upper margin of the base of the bladder, and about an inch (2.5 centimeters) above the prostate gland, the peritoneum is reflected from the rectum to the bladder to form the recto-vesical pouch. The portion of the base in relation with the rectum is triangular in shape. The triangle is bounded behind by the recto-vesical fold of peritoneum; at the sides by the seminal vesical and the vasa deferentia; and its apex extends forward to the base of the prostate gland. This triangle varies in size with the distention of the bladder, as the fold of peritoneum is carried upward by the distended bladder. This triangle almost corresponds to the trigone which is seen on the internal surface of the bladder. In the female the base of the bladder lies in contact with the lower portion of the uterus and the upper part of the vagina.

The **neck or cervix of the bladder** is the constriction at the outlet of the

bladder, and is continuous with the urethra; it is surrounded by the prostate gland in the male and looks downward when the individual is in the vertical position.

The neck of the bladder is held firmly in position by the encircling prostate, which in its turn is held in place by the recto-vesical fascia and the deep layer of the triangular ligament; although slight descent of the prostate and neck of the bladder does occur when the latter organ is much distended.

The **relation of the peritoneum to the surfaces of the bladder** is very important in all operations upon that organ. When empty, the peritoneum covers all portions of the bladder except where it lies in contact with the pubic bones, triangular ligament, and lower part of the rectum or cervix uteri and vagina. When the organ is distended, the area of it which is covered by peritoneum is mostly posterior, and is bounded above by the urachus, below by the line connecting the orifices of the ureters, and at the front of the sides by the obliterated hypogastric arteries.

When the bladder is empty and relaxed, a vertical section of it and the upper part of the urethra is usually Y-shaped. Its upper portion drops downward upon the lower part, making a cup-like depression instead of a convexity at the position of the bladder. As the bladder is distended the depression or concavity disappears. It has been claimed that this cup-like depression is found only after death, and is due to relaxation of the muscle wall, and that even when empty, the bladder, during life, always maintains a rounded form. The latter is the finding in the experience of the author. When moderately distended, it is ovoid in shape, the larger end being directed downward and backward toward the rectum in the male, and toward the uterus and vagina in the female. In its ascent the urachus at the summit of the bladder will carry the anterior fold of peritoneum upward with it, above the level of the pubic bones. When the bladder is well distended, this area lacking peritoneal covering may extend two inches (five centimeters or more) above the pubic crest. Of this fact advantage is taken in the operation of suprapubic cystotomy, the incision entering the bladder without opening the peritoneal cavity. In tapping the bladder above the pubis with a trocar, it is well to push the instrument backward, rather than downward, in order to prevent it from entering the cellular tissue interposed between the bladder and the pubis. Posteriorly, the peritoneum is reflected from the rectum to the bladder, and comes into contact with that organ just above the seminal vesicles and the entrance of the ureters. When the bladder is empty, the sac thus formed, the recto-vesical pouch, may be but two inches (five centimeters) from the anus; when the bladder is distended, it carries this pouch upward until it is an inch (2.5 centimeters) or more higher, thus allowing one to tap the bladder through the rec-

tum without any danger of opening the peritoneal cavity. This operation should not be countenanced by any rational surgeon.

STRUCTURE.—The wall of the bladder is composed of a fibrous, a muscular, a submucous, and a mucous coat, with a peritoneal coat in some parts. Its thickness may vary greatly in different subjects, and even in the same subject under different degrees of distention. It is about one-eighth of an inch (0.7 centimeter) thick when moderately stretched, but when contracted, may reach the thickness of one-half inch (1.3 centimeters). It is thickest at the trigone.

The peritoneal investment of the bladder, by its reflection over the urachus above, and from the side and back of the bladder below, forms the **false ligaments of the bladder**.

The **fibrous coat of the bladder** is continuous with the recto-vesical fascia, and covers the muscular coat. It is thickest near the base of the organ, where it is continuous with the capsule of the prostate and the pubo-prostatic or anterior true ligaments, and is less distinct near the summit of the bladder. At the side it is continuous over the levator ani muscle, and forms the **lateral true ligaments**, while above it is continuous with the urachus, forming the **superior true ligaments**.

The **muscular coat** consists of three layers of unstriated muscular fibers. The *outer layer of muscular fibers* is arranged longitudinally, and is more readily demonstrable than the other two. It is seen best on the anterior and posterior surfaces and the summit of the bladder. At the sides, the fibers are more oblique and irregular. In front they are attached to the prostate in the male, and in both sexes form two muscular bands which are attached to the dorsal surface of the pubic bones close to the symphysis. These bands are the *pubo-vesical muscles*. The *middle muscular layer* is composed of circular fibers, and is most marked at the neck of the bladder, where it forms the *internal sphincter of the bladder*. The *inner muscular layer* is arranged chiefly in a longitudinal direction, although it is somewhat retiform. When the bladder is well distended, this layer of muscular fibers becomes so thin that open meshes are left between them, and pouches of the mucous membrane, or *sacculi*, may form as a result of chronic obstruction to the exit of urine. These muscular fibers may also become hypertrophied and form ridges upon the inner surface of the organ. A stone may be so lodged in a saccule that a sound does not strike it.

The **submucous coat** is placed between the muscular and mucous coats, and consists of areolar and elastic tissues, through which the vessels and nerves ramify.

The **mucous coat**, or mucous membrane, or inner layer, as well as the orifices of the bladder, can be studied after opening the bladder. During life and soon after death the mucous membrane, in the healthy state, will be of a pale rose color.

It is continuous with the mucous membrane of the ureters and with that of the urethra. Except over a small triangular surface behind the vesical orifice of the urethra, it will be seen to be thrown up into many folds, if the bladder is empty. This triangular area is opposite the triangle seen on the external surface of the base of the bladder, which is in relation with the rectum. Inside the bladder, this triangle is bounded on the sides by lines drawn between the vesical orifices of the urethra and ureters, and above by a transverse elevation between the orifices of the ureters, called *plica ureterica*. The apex, which is below, is at the internal opening of the urethra (internal urinary meatus). This triangle is known as the **vesical trigone**. The mucous membrane is closely adherent over this area, whereas over the remainder of the surface it is quite lax, and when not distended arranges itself in folds, or *rugæ*.

The **orifices of the ureters** are situated at the posterior angles of the trigone, are about two inches (five centimeters) apart, and about an inch and one-half (four centimeters) from the internal urinary meatus. A slight elevation of the mucous membrane, the **uvula vesicæ**, or **uvula of Lieutaud**, projects forward into the internal urinary meatus. It is smaller in the female.

The female bladder usually presents a lessened antero-posterior diameter, owing to the encroachment of the vagina and uterus; and an increased lateral diameter, owing to the greater width of the pelvis. As the symphysis pubis is of less depth than in the male, the urinary orifice lies nearer its lower border. Lateral asymmetry is frequently observed in the female bladder.

RELATIONS.—In the adult the bladder, when empty or containing little urine, is in relation, in front and below with the base of the prostate gland, the pubo-prostatic ligaments, and the body of the pubes; behind with the peritoneum, rectum, ureters, vasa deferentia, and vesiculæ seminales, in the male, and the ureters, uterus, and vagina in the female; the superior and posterior surfaces are covered by peritoneum.

The **ligaments of the bladder** are five true—two anterior, two lateral, and a superior (the urachus); and five false, consisting of peritoneal folds—two posterior, two lateral, and one superior.

Of the *true ligaments*, the anterior or *pubo-prostatic ligaments* are formed by the recto-vesical fascia, and extend from the posterior surface of the pubic bones at the sides of the symphysis to the neck of the bladder and base of the prostate. They contain some muscular fibers which are continuous with the external muscular layer of the wall of the bladder. The *lateral true ligaments* extend from the sides of the prostate and base of the bladder to the levator ani muscle. They also are formed by the recto-vesical fascia. The *superior true ligament* is formed by the urachus, which is an obliterated portion of the allantoic stalk extending from

the summit of the bladder to the umbilicus. These are all continuous with the fibrous coat of the bladder-wall.

Of the *false ligaments*, the two *posterior* are the recto-vesical folds (utero-vesical in the female), and contain the obliterated hypogastric arteries, the ureters, and vessels and nerves passing to the bladder. The *lateral false ligaments* are peritoneal folds extending between the sides of the bladder and the lateral walls of the pelvic cavity. The *superior false ligament* is the fold of peritoneum which passes from the summit of the bladder to the abdominal wall and covers the urachus and obliterated hypogastric arteries.

BLOOD SUPPLY.—The blood supply of the bladder is derived from the superior, middle, and inferior vesical, obturator and internal pudic arteries, and also from branches from the uterine and vaginal arteries, in the female.

The **veins** form a large plexus about the organ, especially marked at its base, where they communicate with the prostatic plexus and form the **vesico-prostatic plexus**; they empty into the internal iliac vein.

The **lymphatics** accompany the blood-vessels and empty into the pelvic glands.

NERVE SUPPLY.—The nerve supply of the bladder is derived from the pelvic plexuses of the sympathetic, and through these plexuses its nerves are chiefly derived from the third and fourth sacral nerves.

Rupture of the bladder may occur from overdistention, or from direct violence applied to a bladder which is distended. It may rupture at its posterior part, and the urine be poured into the peritoneal cavity; or it may tear at its anterior or nonperitoneal portion, and the urine be extravasated into the pelvic extraperitoneal connective tissue. In the former instance a violent and fatal peritonitis will result unless the condition is detected early, the abdominal and pelvic cavities aseptically cleansed, the bladder rent sewed, and a catheter left in the urethra to drain off the urine as quickly as it reaches the injured viscus. The symptoms of intraperitoneal rupture of the bladder are inability to urinate after the injury, collapse of the organ, and little or no urine and some blood in the bladder, and the catheter may sometimes be carried into the abdomen; warm sterile water injected into the bladder disappears and can not be drawn off. Cases have occurred in which abdominal dropsy was mistaken for a distended bladder, and the catheter pushed through the bladder into the peritoneal cavity under the supposition that it had not been introduced far enough, thus emptying the belly of its serum under the mistaken impression that the fluid came from the bladder.

The **Ureters** dip into the pelvis over the iliac vessels near the bifurcation of the common iliac artery, whence they curve downward, forward, and a little inward in the extraperitoneal connective tissue and beneath the posterior false ligaments

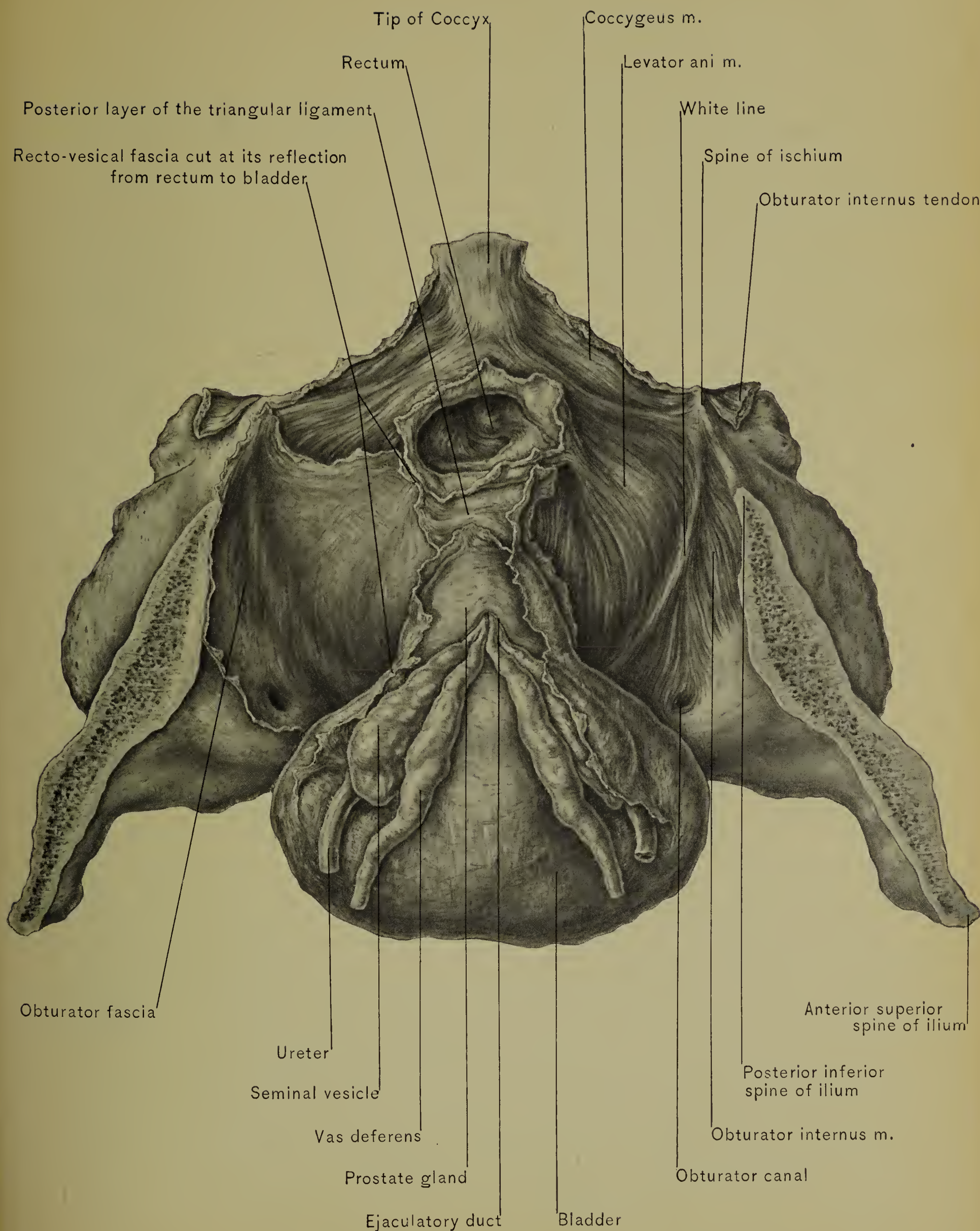
of the organ to the back of the base of the bladder. They enter the bladder very obliquely, about two or two and one-fourth inches (5 to 5.5 centimeters) back of the prostate and one inch (2.5 centimeters) external to the median line. They pass obliquely downward and inward through the wall of the bladder for about a half inch (1.3 centimeters) and open into the bladder about one inch (2.5 centimeters) from the internal urinary meatus and from each other. The ureter is narrowest at the vesical orifice, and for that reason a calculus is more likely to be arrested at that point. The mode of entrance of the ureters produces a valve-like orifice which allows the urine to flow into the bladder, and at the same time prevents regurgitation of urine. In the posterior false ligaments the ureters cross behind and below the obliterated hypogastric arteries, and are crossed by the vasa deferentia which run between them and the bladder and then internal to them. *In the female* they lie behind the broad ligaments in their descent and then pass forward under them. They next run directly through the plexus of veins situated behind the loop of the uterine artery, and here lie one-third to three-fifths of an inch (1.0 to 1.5 centimeters) from the side of the cervix. They finally run to the side of the vagina, then pass in front of it, and enter the bladder in front of the upper portion of the vagina. In this location a calculus in the ureter can be palpated. In the pregnant female the posterior part of the large curve formed by the ureters is straightened out by being lifted upward with the broad ligament. It is still behind this ligament, immediately beneath the peritoneum. Although the greater part of the curve changes, the lower part remains the same as in the non-pregnant condition, so that there is no interference with the ureters at their entrance into the bladder.

BLOOD SUPPLY.—The blood supply of the ureters is derived from the renal, spermatic or ovarian, internal iliac, and vesical arteries. The veins correspond to the arteries. The lymphatics empty into the pelvic and lumbar glands.

NERVE SUPPLY.—The nerve supply of the ureters is derived from the sympathetic plexuses in relation with arteries which furnish their blood supply.

The **Prostate** is a firm, musculo-glandular body situated at the neck of the bladder and surrounding the first or prostatic portion of the urethra. In shape it is irregularly pyramidal, and resembles a horse-chestnut. In breadth it measures one and one-half inches (3.75 centimeters) from side to side at the base (its widest part), and its length is one and one-fourth inches (three centimeters). It is flattened from before backward and its antero-posterior diameter is slightly less than three-fourths of an inch (1.8 centimeters). It weighs about six drams (twenty-four grams). Behind, it rests upon the anterior wall of the rectum an inch and a half to two inches (four to five centimeters) above the anus.

The **base of the gland** is directed upward toward the bladder, is attached to



BLADDER, PROSTATE, SEMINAL VESICLES, VASA DEFERENTIA.

the muscular coat of the wall of that organ, and is nearly opposite the middle of the symphysis pubis. The **apex** is directed downward, and situated just above the deep layer of the triangular ligament. The **anterior surface** is one-half to three-fourths of an inch (1.5 to 2 centimeters) behind the lower half of the symphysis pubis and is in relation with the prostatic plexus of veins, fat, and areolar tissue. The **posterior surface** is in relation with the rectum. Its **lateral surfaces** are opposed to the anterior fibers of the levator ani muscle which supports the gland, and are called the levator of the prostate. An irregular artery, usually a branch of the internal iliac, is sometimes found running along the side of the prostate gland on its course to the dorsum of the penis. It may be the source of dangerous hemorrhage in lateral lithotomy.

The prostate is inclosed in a dense fibrous **capsule** formed by the recto-vesical fascia. The anterior portion of the capsule is continuous with the pubo-prostatic or anterior true ligaments of the bladder. By incising the capsule, the gland will be brought into view.

The base of the prostate is surrounded by the thick **prostatic plexus of veins**, which is most marked upon its sides and anterior surface. It receives the dorsal vein of the penis, which runs along the anterior aspect of the prostate and divides into two portions which are lost in the prostatic plexus. The plexus also receives the veins from the vesical plexus, veins from the prostate, and communicates with tributaries of the internal pudic vein. In old men these veins often become distended and tortuous, phleboliths are not uncommon, and the resulting obstruction causes cyanosis of the penis.

The prostate is divided into **two lateral lobes** by an **anterior** and a **posterior median furrow**. A slight bulging of the gland toward the bladder, between the neck of the bladder and the prostatic urethra in front, and the two lateral lobes at either side and behind, is called the **third** or **middle lobe**. This lobe varies much in size, and may even be absent; and when hypertrophied, as in an old man, is a cause of retention of urine and dysuria. On the posterior surface of the gland this lobe is bounded in front by a transverse cleft, the **prostatic fissure**, which extends deeply forward toward the middle of the prostatic urethra and contains the ejaculatory ducts and the sinus pocularis. This fissure really cuts off the so-called middle lobe from the rest of the organ.

STRUCTURE.—Three-fourths of the prostatic body is composed of unstriated muscular tissue, and about one-fourth of it consists of branched tubular glands which are more plentiful beneath the urethra. The muscular tissue is continuous with the sphincter of the bladder, and the ducts of the glands empty into the prostatic sinuses. The secretion of the gland dilutes and gives bulk to the semen. The contraction of the muscular tissue at the base of the gland is supposed to pre-

vent regurgitation of the semen into the bladder, and the remainder to assist in accelerating its passage through the urethra. Near the apex the gland is probably connected by striated muscular fibers with the transversus perinei muscle.

BLOOD SUPPLY.—The blood supply of the prostate is derived from the middle hemorrhoidal, inferior vesical, and internal pudic arteries. The veins enter the prostatic plexus.

NERVE SUPPLY.—The nerve supply of the prostate is derived from the hypogastric plexus of sympathetic nerves.

The **lymphatics** follow the vessels and empty into the lumbar glands.

The **Prostatic Urethra** is that portion of the urethra which is inclosed by the prostate. It measures about one and a quarter inches (three centimeters) in length, is wide at its commencement at the bladder and narrowest as it leaves the apex of the gland and enters the triangular ligament. Longitudinally, along the middle of the floor of the prostatic urethra, there is a narrow fold or ridge composed of mucous membrane and the subjacent structure of the prostate; it is called the **verumontanum** (**urethral crest, caput gallinaginis, or colliculus seminalis**). The verumontanum is highest at its middle and gradually fades away at either end. Upon each side of this is a furrow called the **prostatic sinus** which contains the orifices of the **prostatic ducts**, which carry the secretion from the glandular tissue of the prostate. In the front part of the verumontanum, and just anterior to its highest portion, is a small blind pouch, the **sinus pocularis** (**vesicula prostatica or uterus masculinus**), which is the homologue of the uterus. In its lateral margins are the slit-like orifices of the ejaculatory ducts. The ejaculatory ducts and sinus pocularis occupy the prostatic fissure which bounds the middle lobe of the prostate in front.

The **uterus masculinus** is a pocket about one-half inch (1.5 centimeters) in length, and extends upward and backward under the verumontanum into the prostatic fissure. Its wall has a musculo-fibrous structure, contains the ejaculatory ducts, and is lined with mucous membrane, upon the inner surfaces of which small glands open. These glands are analogous to the uterine glands.

The **seminal vesicles** are irregularly lobulated and elongated pouches situated along the sides of the triangular area at the base of the bladder. They are widest at their upper free divergent ends, where they measure one-half inch (1.3 centimeters), and are quite narrow at their convergent ends, where they join the vasa deferentia opposite the base of the prostate. They are about two and one-half inches (6.4 centimeters) in length, and about a quarter of an inch (0.6 centimeter) in thickness. They are irregular in size and outline, even differing considerably on the two sides in one individual. Posteriorly, they rest upon the recto-vesical fascia and rectum. Upon the inner side of each vesicle is

the lower, enlarged, convoluted end of the vas deferens. The triangular area of the bladder located between the diverging vasa deferentia and seminal vesicles rests upon the rectum and corresponds with the trigonum vesicæ. The seminal vesicles are covered by a fibrous sheath, which is derived from the rectovesical fascia and contains some involuntary muscular tissue. When this sheath is removed, the seminal vesicles are observed to be composed of a tortuous tube four or five inches (10 to 12.5 centimeters) in length. The tube is about the width of a goose-quill, presents several blind branches or diverticula, is closed at its upper end, and opens below into the ejaculatory duct.

BLOOD SUPPLY.—The blood supply of the seminal vesicles is derived from the inferior vesical and middle hemorrhoidal arteries.

NERVE SUPPLY.—The nerve supply is from the pelvic sympathetic plexuses.

FUNCTION.—The function of the seminal vesicles is to secrete a fluid, which augments the bulk of the semen.

The **Vas Deferens**, the duct of the testis, is the continuation of the epididymis, and extends from the globus minor to the prostatic portion of the urethra. It passes upward in the spermatic cord and enters the abdominal cavity through the internal abdominal ring, where it lies to the outer side of the deep epigastric artery. Thence it runs in the extraperitoneal fat anterior and internal to the external iliac vessels and obliterated hypogastric artery, and passes into the pelvis to the side of the bladder. It passes downward and backward upon the side of the bladder to its base, running between the bladder and ureter, and then internal to the latter. It runs along the inner side of the seminal vesicle between the base of the bladder and the rectum as a dilated tube or *ampulla* which contains pouches or *sacculi*. Opposite the base of the prostate it abruptly becomes narrow and joins the open end of the seminal vesicle to form the ejaculatory duct.

According to its relations and position during its course and extent, the vas deferens has been described in four portions: viz., the **testicular portion**, extending along the epididymis from the globus minor to the top of the testicle; the **funicular portion**, extending from the latter point to the external abdominal ring; the **inguinal portion**, occupying the inguinal canal; and the **pelvic portion**, extending from the internal abdominal ring to the termination at the ejaculatory duct.

The vas deferens is about twenty-four inches (sixty centimeters) long, six inches (15.2 centimeters) being situated in the spermatic cord and along the epididymis, and the balance in the general abdominal cavity. In the terminal dilated portion of the duct its walls are comparatively thin and its lumen large. The diameter of this portion of the duct is about one-tenth of an inch (0.25 centimeter), the wall is about one twenty-fifth of an inch (0.1 centimeter) thick, and

its lumen measures about one-fiftieth of an inch (0.05 centimeter). The thickness of its walls gives the duct its cord-like character.

The **Ejaculatory Duct**, one on each side, is formed by the union of the seminal vesicle and vas deferens opposite the base of the prostate, and passes forward, downward, and inward, behind the middle lobe of the prostate and through the prostatic fissure to open into the floor of the prostatic urethra on the verumontanum at the lateral margin of the sinus pocularis. It is about one-eighth of an inch (0.3 centimeter) wide above, and narrows to about one twenty-fifth of an inch (one millimeter) near its termination, its lumen decreasing to one-fiftieth of an inch (0.5 millimeter). It is about three-fourths of an inch (two centimeters) in length.

The **Nerves of the Pelvis** are the sympathetic and the spinal.

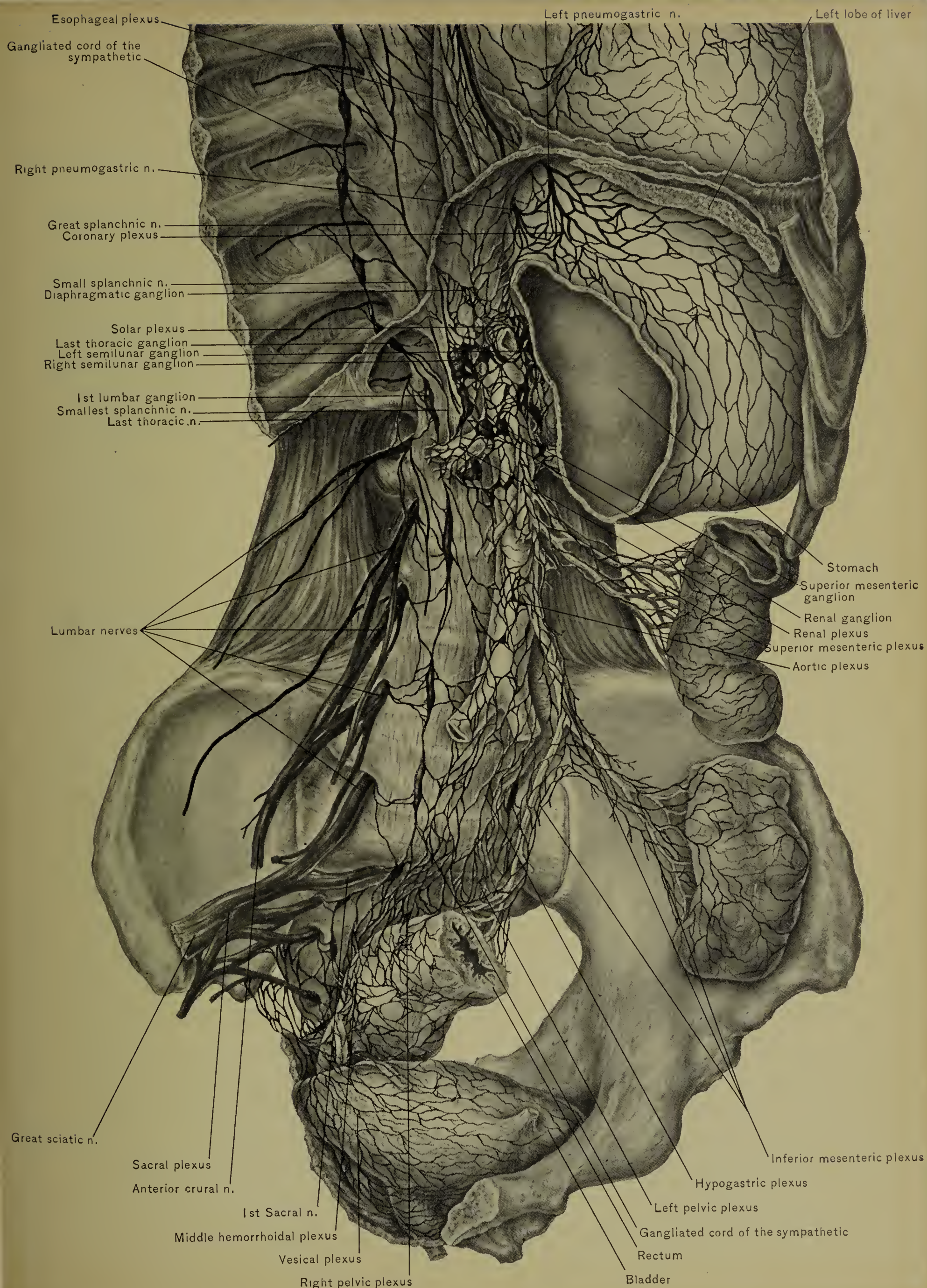
The **sympathetic nerve cords** of the pelvis are, like those of the neck, thorax, and abdomen, arranged in two chains of ganglia. Each of these chains of ganglia is composed of four or five ganglia which are situated upon each side of the front of the sacrum internal to the anterior sacral foramina, the adjacent ganglia being connected by non-medullated nerve-fibers. Branches from the lowest ganglia join together upon the front of the coccyx into a single small ganglion (*ganglion impar*). The *external branches* of these ganglia, two from each ganglion, like those higher up, communicate with the corresponding sacral nerves, the last one either with the last sacral or the coccygeal nerve. The internal branches communicate with the opposite counterparts across the front of the sacrum, the upper two branches sending filaments to the hypogastric and pelvic plexuses, while the others form a plexus which accompanies the middle sacral artery.

The **hypogastric plexus** of nerves lies upon the sacral promontory between the common iliac arteries; it is formed by filaments from the aortic plexus, lumbar ganglia, and first two sacral ganglia. It contains no ganglia and divides below into the two inferior hypogastric or pelvic plexuses. It sends filaments to the pelvic viscera.

The **inferior hypogastric or pelvic plexuses** are downward and forward continuations of the bifurcated hypogastric plexus, receiving reinforcing filaments from the second, third, and fourth sacral nerves, and from the sacral ganglia. These plexuses lie upon the sides of the rectum. Branches following the course of the corresponding blood-vessels are given off to the pelvic viscera.

The middle **hemorrhoidal plexus** arises from the back part of the pelvic plexus. It supplies the rectum and inosculates with the inferior mesenteric plexus above, and branches of the internal pudic nerve below.

The **vesical plexus** is derived from the pelvic plexus and chiefly from the fibers derived from the third and fourth sacral nerves. It supplies the bladder,



SYMPATHETIC PLEXUS.

upon the side and base of which its branches accompany the vesical arteries. The plexus contains many medullated nerve-fibers which are derived from the spinal nerves. They send filaments to the seminal vesicles and vas deferens, some of the latter continuing in the spermatic cord with the spermatic plexus.

The **prostatic plexus** lies below the vesical plexus, is connected with it, and is formed by large nerves given off from the lower part of the pelvic plexuses.

Along the side of the prostate, ganglia are developed (ganglia prostatica) from one-fourth to one-half inch in length (0.6 to 1.3 centimeters). Branches of these ganglia pass to the prostate, to the vesiculæ seminales, and to the corpora cavernosa of the penis in the male and the clitoris in the female. These latter are called cavernous nerves.

The **vaginal plexus** is formed from the lower part of the pelvic plexus, and supplies the mucous lining of the vagina, the erectile tissue at its forward part, and the clitoris. It contains many medullated nerve-fibers derived from the spinal nerves.

The **uterine plexus** is also derived from the lower part of the pelvic plexus, but above its accessions from the sacral nerves. It passes between the folds of the broad ligament in company with the uterine arteries, and its branches, with others from the ovarian plexus, enter the substance of the uterus to supply that organ.

The **spinal nerves in the pelvis** are the sacral and coccygeal.

There are five *sacral nerves* on each side. They all pass through the sacral foramina except the last sacral nerve, which emerges from the spinal canal between the sacrum and coccyx, and communicate with the gangliated cord of the sympathetic by rami communicantes. They divide into anterior and posterior branches.

The *posterior divisions of the sacral nerves* have been described with the back of the neck, shoulders, and trunk.

The *anterior divisions of the sacral nerves* are much larger than the posterior divisions, and grow smaller from above downward. The upper three and part of the fourth, together with the lumbo-sacral cord, form the *sacral plexus*.

The *fourth sacral nerve* divides into an ascending branch which enters the sacral plexus, and a descending branch which enters the coccygeal plexus. The nerve also gives off muscular and cutaneous branches. A *perineal branch* pierces the floor of the pelvis by passing between the coccygeus and levator ani muscles, and near the tip of the coccyx supplies filaments to the external sphincter ani muscle and skin. A *gluteal cutaneous branch* (perforating cutaneous) pierces the great sacro-sciatic ligament, runs under the gluteus maximus muscle, winds around the lower border of the muscle, and supplies the skin over its lower and inner part. *Muscular branches* supply the levator ani and coccygeus muscles.

The *anterior division of the fifth sacral nerve* divides into an ascending and a descending branch which assist in forming the coccygeal plexus.

The *coccygeal plexus* is formed by the anterior division of the last three spinal nerves; *i. e.*, by the descending branch of the fourth sacral nerve, the ascending and descending branches of the fifth sacral nerve, and the coccygeal nerve. Some of the branches of this plexus enter the hypogastric plexus, and others supply the coccygeus and gluteus maximus muscles and the skin over the coccyx.

The *anterior division of the coccygeal nerve* supplies the coccygeus muscle and filaments to the gluteus maximus.

The **sacral plexus** is formed by the anterior divisions of some of the lower spinal nerves. Just below the brim of the pelvis a part of the anterior division of the fourth lumbar joins the anterior division of the fifth lumbar nerve to form the *lumbo-sacral cord*. This cord joins the anterior divisions of the upper three sacral nerves to form the plexus, the fourth sacral nerve also contributing to it by supplying a branch to the pudic nerve. Therefore, the sacral plexus is formed by the lumbo-sacral cord, the upper three sacral nerves, and part of the fourth sacral nerve. Its shape is triangular. The base of the triangle is situated at the intervertebral foramina, while the apex formed by the branches of the plexus is located at the lower part of the great sacro-sciatic foramen. The sacral plexus lies in front of the pyriformis muscle, and is covered anteriorly by the parietal pelvic fascia which separates it from the pelvic vessels and viscera. The uppermost roots are the longer, and the lowermost, the shorter. The sciatic artery passes between the nerve-roots at the lower part of the plexus, and the superior gluteal artery between the lumbo-sacral cord and the anterior division of the first sacral nerve. The *branches* of this plexus are the great and small sciatic, pudic, superior and inferior gluteal, muscular, and visceral. These may be classified as *collateral* and *terminal*. The *collateral* branches are the superior and inferior gluteal, the small sciatic, muscular, and visceral. The *terminal* branches are the great sciatic and the pudic nerves.

The *great sciatic nerve* is the continuation of the apex of the sacral plexus. It is the largest nerve in the body, being half an inch (1.25 centimeters) in width and nearly half as thick. It leaves the pelvis through the great sacro-sciatic foramen, usually under the pyriformis, but sometimes over or through it, or it may even be pierced by that muscle. It may also consist of two strands, one perforating the muscle and the other passing either above or below it. These strands may reunite below the muscle or continue as the external and internal popliteal nerves. Below the pyriformis, the great sciatic nerve is covered by the gluteus maximus muscle and the upper end of the long head of the biceps, and passes downward over the external rotators of the thigh, between the tuber ischii and trochanter

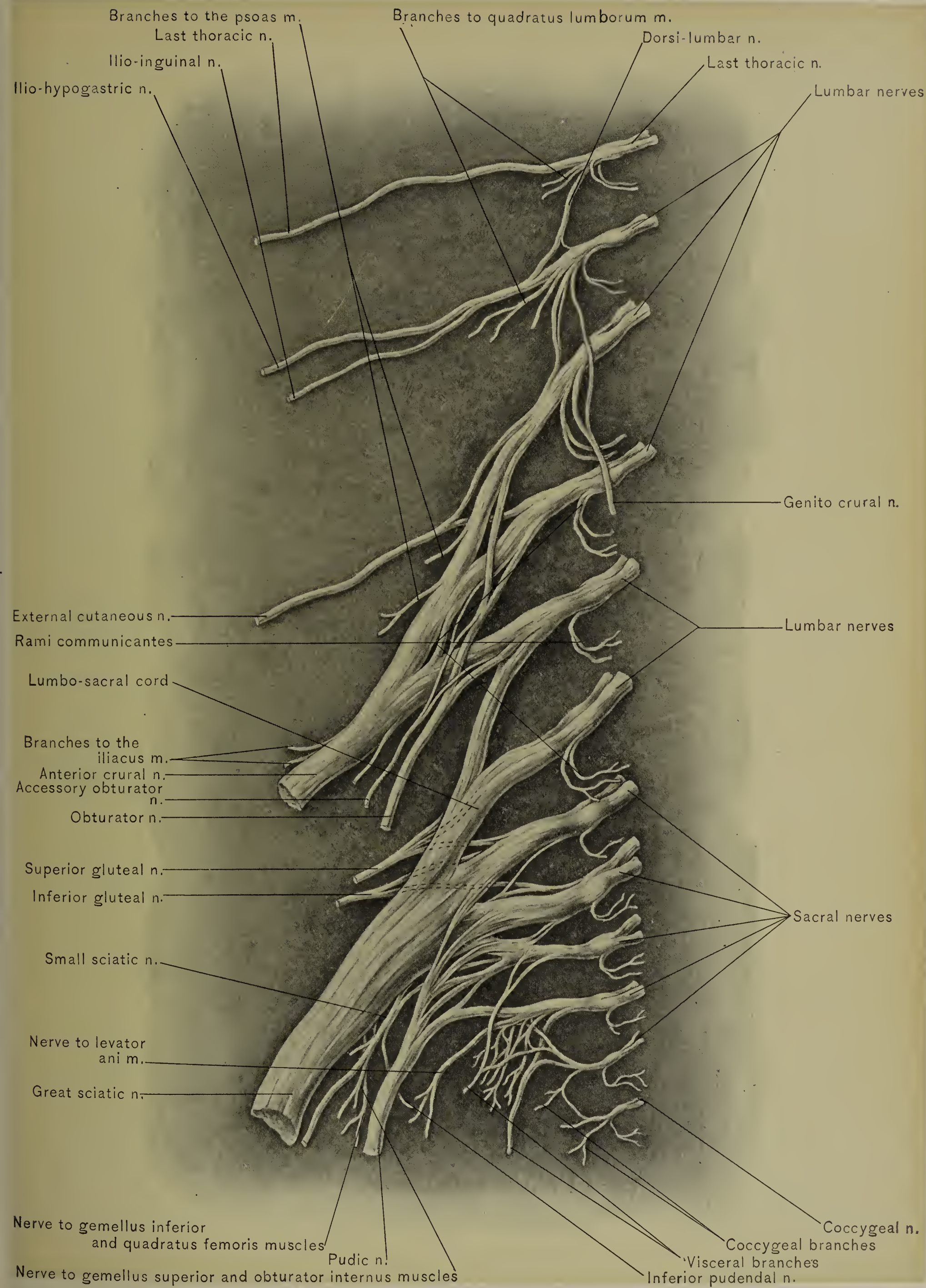


DIAGRAM OF LUMBAR PLEXUS.

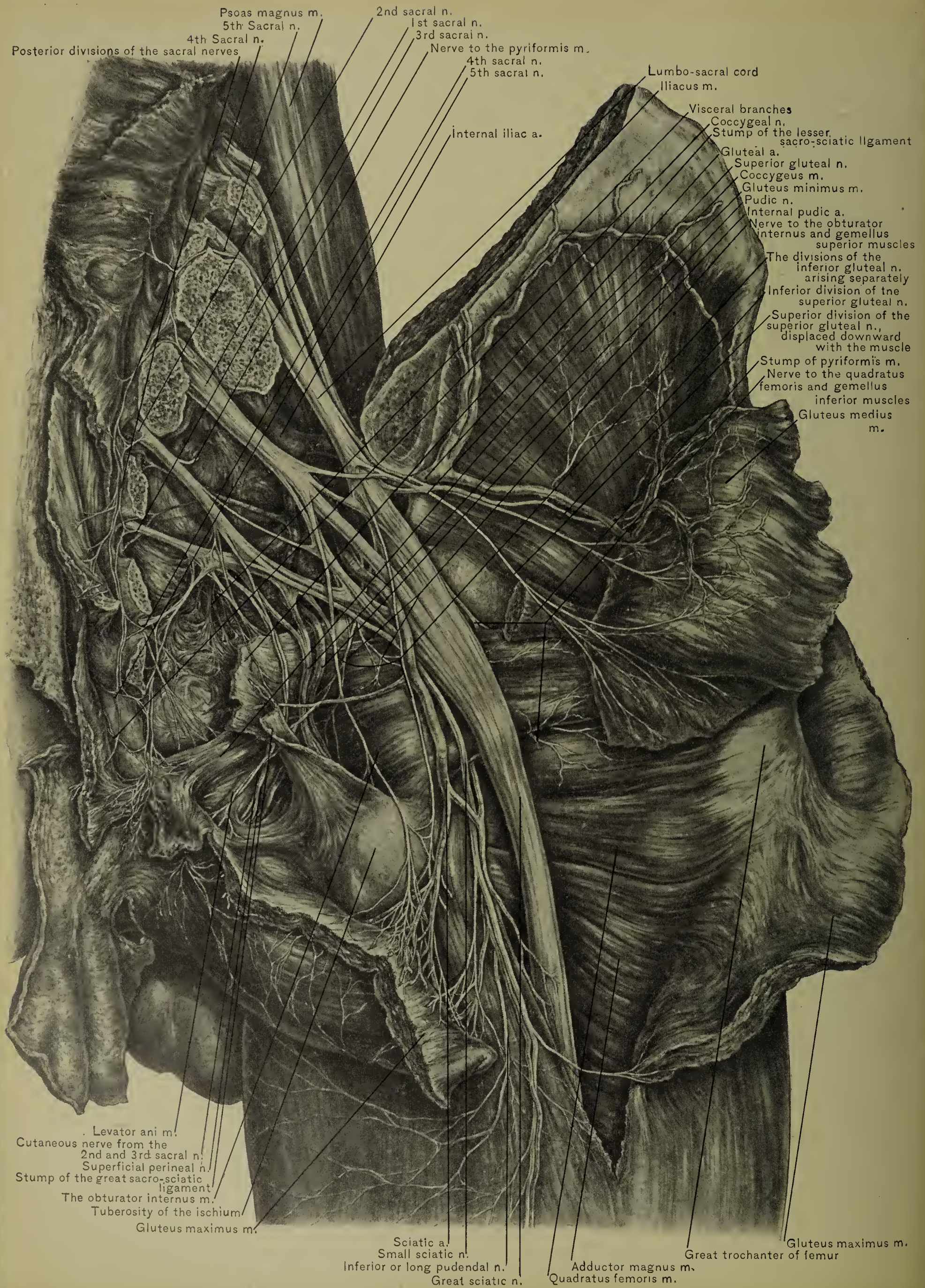


DIAGRAM OF SACRAL PLEXUS.

major, but nearer the tuber ischii. The remainder of its course is described with the lower extremity.

The *pudic nerve* arises from the second, third, and fourth sacral nerves. It passes out of the pelvis through the great sacro-sciatic foramen, below the pyriformis muscle, accompanies the internal pudic vessels across the spine of the ischium, reenters the pelvis by way of the lesser sacro-sciatic foramen, and, ensheathed by the obturator fascia, passes forward in the outer wall of the ischio-rectal fossa and divides into the perineal and dorsalis penis nerves. The pudic nerve, as it passes through the lesser sacro-sciatic foramen, usually gives off the *inferior hemorrhoidal nerve* which is accompanied by the *inferior hemorrhoidal vessels*. It crosses the ischio-rectal fossa to the lower end of the rectum, where it supplies muscular branches to the external sphincter ani, cutaneous filaments to the peri-anal integument, and communicating branches to the inferior pudendal and superficial perineal nerves. The perineal and dorsalis penis nerves are described in the discussion of the perineum and penis respectively.

The *superior gluteal nerve* arises from the lumbo-sacral cord and the first sacral nerve. With the superior gluteal artery, it enters the gluteal region through the great sacro-sciatic foramen above the pyriformis muscle. Like the artery, it divides into a superior and an inferior branch which run between the gluteus medius and gluteus minimus muscles. The *superior branch* supplies the gluteus medius and gluteus minimus, and the *inferior branch* these muscles and the tensor fascia femoris muscle.

The *inferior gluteal nerve* arises from the second and third sacral nerves, and leaves the pelvis through the great sacro-sciatic foramen below the pyriformis muscle. It supplies the gluteus maximus muscle. As it is usually adherent to the small sciatic nerve, it is sometimes described as a branch of that nerve.

The *small sciatic nerve* arises from the posterior surface of the second and third sacral nerves. It leaves the pelvis through the great sacro-sciatic foramen below the pyriformis muscle, running downward on the posterior surface of the great sciatic nerve, and is accompanied by the sciatic artery in its downward passage beneath the gluteus maximus, to which muscle it gives a branch that probably is derived from the inferior gluteal nerve which is adherent to the small sciatic nerve in this region. Its further course is described with the lower extremity.

The *muscular branches* of the sacral plexus supply the pyriformis, obturator internus, two gemelli, and quadratus femoris muscles.

The *nerve to the pyriformis muscle* arises from the second or third sacral nerve.

The *nerve to the obturator internus muscle* arises from the cord formed by the union of the lumbo-sacral cord with the first sacral nerve. It accompanies the internal pudic vessels and pudic nerve through the great sacro-sciatic foramen, over

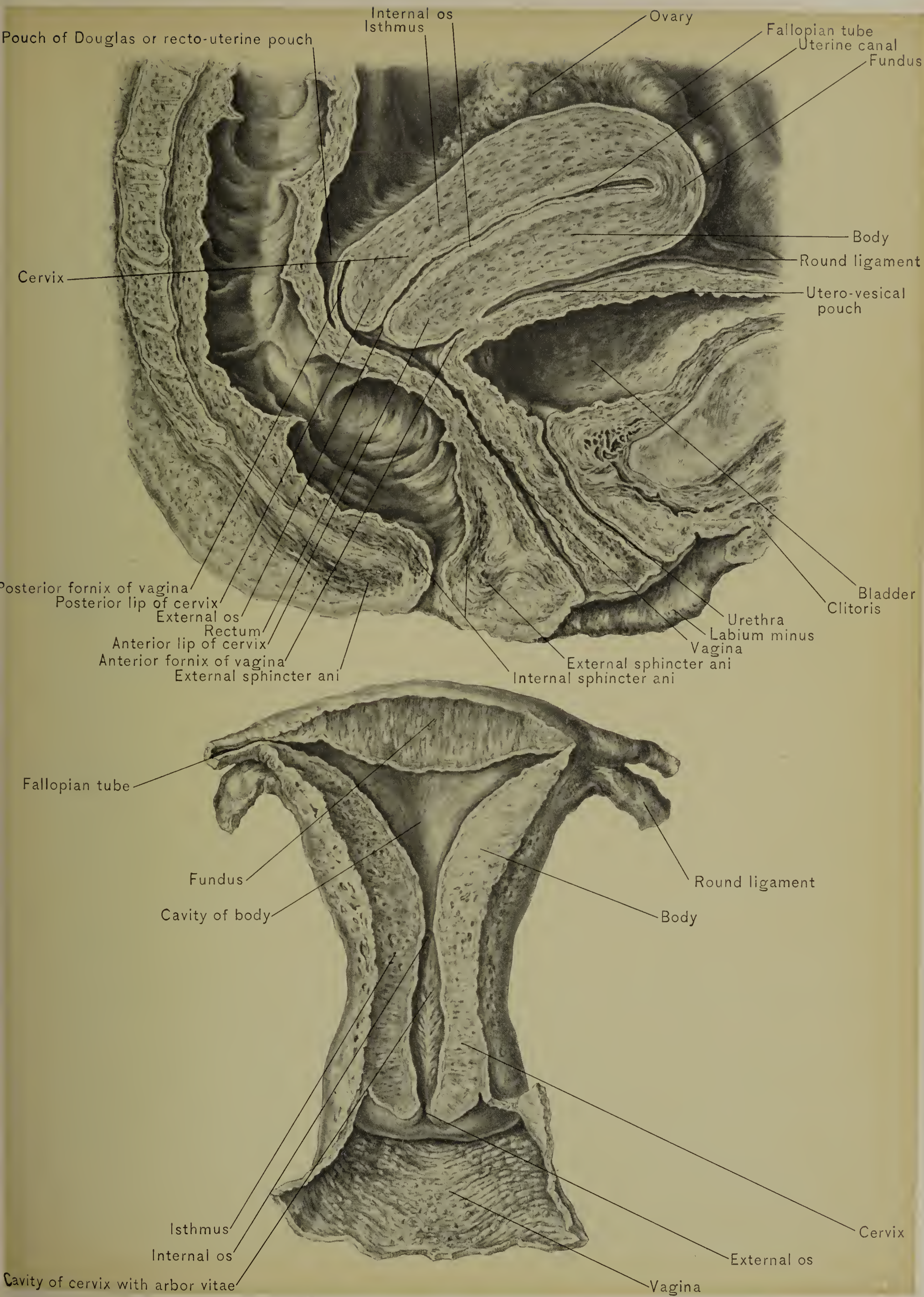
the spine of the ischium, and through the lesser sacro-sciatic foramen to the inner surface of the obturator internus muscle which it supplies. It also gives a branch to the superior gemellus muscle. Another branch to the gemellus superior muscle is given off from the lower part of the sacral plexus.

The *nerve to the quadratus femoris muscle* is a branch of the third sacral nerve and also supplies the inferior gemellus muscle. It passes through the lower part of the great sacro-sciatic foramen, and then beneath the gemelli muscles and the tendon of the obturator internus and over the capsule of the hip-joint to the anterior or deep surface of the quadratus femoris. It also sends an *articular branch* to the hip-joint.

The *visceral branches of the sacral plexus* are derived from the third, fourth, and fifth sacral nerves. They enter the pelvic or inferior hypogastric plexus.

The **Uterus**, or **Womb**, is a hollow viscus which has thick muscular walls and projects upward from the vagina into the female pelvic cavity between the rectum and bladder. It is pyriform in shape and its anterior and posterior surfaces are flattened. It is about three inches (7.5 centimeters) long, two inches (five centimeters) wide at its broadest part, and about one inch (2.5 centimeters) thick from before backward. The weight of the virgin uterus is about seven drams (twenty-eight grams), that of the post-parous organ about twelve drams (forty-eight grams). The uterus is divided into a body, an isthmus, and a cervix or neck.

The **body of the uterus** has the form of a truncated cone whose apex is at the isthmus. The base of the cone is rounded, directed upward, and called the *fundus*. It is that portion of the uterus which projects above the entrance of the Fallopian tubes, and forms the roof of the uterine cavity. The body has two surfaces, three margins, and two superior angles. The *anterior surface* is flattened, and covered by peritoneum, which at the level of the isthmus is reflected upon the bladder, forming the utero-vesical pouch. This surface is in relation with the peritoneum and the bladder. Usually there are no intestinal coils between the uterus and bladder, though in women who have been pregnant the fundus may point somewhat backward, and then some portion of the intestine may occupy the utero-vesical pouch. The *posterior surface* is convex and covered by peritoneum which descends to the posterior wall of the vagina, from which it is reflected to the rectum and forms the *pouch of Douglas*, or recto-vaginal pouch. This pouch is slightly deeper on the left than on the right side. This surface is in relation with the peritoneum, rectum, coils of small intestine, and sigmoid flexure. The *lateral margins* give attachment to the broad and round ligaments which swing the uterus in the pelvic cavity and to the ovarian ligaments. The superior border of the uterus is rounded and is covered by



SECTIONS OF UTERUS AND VAGINA.

peritoneum. From the *superior angles*, or *cornua*, of the uterus extend the Fallopian tubes.

The **isthmus** is the narrow or constricted part of the uterus situated at the junction of the body and cervix of that organ. It is most marked in infants, but becomes less apparent as puberty approaches, and may disappear entirely after parturition. In the virgin uterus it is located at about the middle of the organ, while in the post-parous uterus it is found at the junction of its middle and lower thirds. The isthmus is the weak part of the organ, where pathologic flexures occur, and where rupture during parturition is most likely to take place.

The **cervix** is the lowest of the three portions of the uterus and projects downward into the vagina. In the virgin it composes one-half of the length of the uterus; in the organ which has borne children, about one-third. It is cylindrical in form and constricted at each end. Its surface may be divided into a supravaginal portion, a zone of vaginal attachment, and an intravaginal portion. The *supravaginal portion* composes two-thirds of the cervix anteriorly and about one-half of it posteriorly. Anteriorly it is in relation with the bladder, posteriorly it is covered by peritoneum, and laterally it is attached to the broad ligaments and is in relation with the uterine vessels and the ureter which is one-third to three-fifths of an inch (0.8 to 1.5 centimeters) from the cervix. The *zone of vaginal attachment* is placed highest posteriorly and inclines downward as the anterior surface of the cervix is approached. For that reason the anterior wall of the intravaginal portion is less than one-third of the anterior wall of the cervix, although on the posterior wall the intravaginal portion is one-half the length of the cervix. The *intravaginal portion* of the cervix is a cone-shaped body, the extremity of which presents the external opening of the cavity of the uterus, the *external os*. In the virgin the external os is a rounded opening, but after childbirth it takes the form of a transverse slit. Under the latter condition it is very easy to divide the lower end of the cervix into an *anterior* and a *posterior lip*. The anterior lip is lower than the posterior, but, owing to the higher attachment of the vaginal wall behind, the posterior lip seems to be longer. These lips usually become notched and irregular in outline after childbirth. A tear or laceration of the cervix often takes place during parturition. This may be unilateral, bilateral, or stellate, and may require repair. It is a proved fact that carcinoma is more likely to develop in a cervix that has been torn. A smooth mucous membrane, similar to that of the vagina, covers the intravaginal portion of the cervix.

Atresia of the cervix may result from injuries, operations, or the application of caustics; or it may be a congenital condition. It causes retention of the menstrual fluid, as soon as menstruation begins, the uterus and Fallopian tubes becoming

distended with blood, which sooner or later also escapes into the pelvic cavity and accumulates in Douglas' pouch.

The position of the uterus is normally in the anterior and central portion of the female pelvis, slightly to the left of the median line, between the bladder and rectum. Owing to the firm attachments of ligaments that hold it in position the cervix is not very mobile. The position of the fundus is very variable, but probably it most usually points in the direction of the long axis of the body. Distention of bladder and rectum and intra-abdominal pressure change the position of the fundus, while circumstances that diminish or modify the support of the organ, such as tears of the pelvic floor, usually bring about displacements of the entire organ.

The displacements of the uterus that may occur are anteversion, anteflexion, retroversion, retroflexion, prolapse, and inversion.

The uterus in nullipara is usually found anteflexed or anteverted. In retroversion and retroflexion the fundus is found turned backward and can be felt through the rectum.

By anteversion is meant a turning forward of the entire organ, while anteflexion signifies that the fundus is bent forward upon itself at the isthmus, so as to form an angle with the cervix. When the uterus occupies those positions, coils of small intestine and the omega loop (sigmoid flexure) rest upon the posterior surface of the organ and lie in Douglas' pouch. When the uterus is retroflexed or retroverted, the intestines occupy the uterovesical pouch.

Anteversion and anteflexion may be caused by strong sacro-uterine ligaments, by firm attachment of the organ to the base of the bladder, or by an imperfectly developed vagina. Retroflexion and retroversion are brought about by the relaxation of the broad, sacro-uterine, and round ligaments, intra-abdominal pressure being the direct cause of the displacement, injuries to the pelvic floor usually the primary cause.

Prolapse of the uterus is caused by the relaxation of the pelvic floor and intra-abdominal pressure, the uterus descending to the vaginal outlet, after carrying the vagina and bladder with it. Inversion of the uterus is a condition in which the organ is turned inside out and forced downward toward the vulvar orifice.

The **cavity of the uterus** is about two and one-half inches (6.25 centimeters) long in the virgin and three inches (7.5 centimeters) in length in the post-parous womb, and its anterior and posterior walls are normally in contact. It is divided into three portions—the cervical canal, the internal os, and the cavity of the body. The *cervical canal* is about one inch (2.5 centimeters) long, and is spindle-shaped. On the anterior and posterior walls are found ridges, formed by longitudinal folds of mucous membrane, from which other folds extend obliquely; this arrangement

is called the *arbor vitæ*. The *arbor vitæ* is usually obliterated by the first childbirth. The mucous membrane which lines the cervical canal contains numerous small mucous glands (glands of Naboth) which secrete a thick, tenacious mucus. At times the ducts of these follicles become occluded, and the glands become distended with their secretion, thus forming small cysts, called *ovula of Naboth*. The *internal os* is the narrowest part of the cavity of the uterus, and is within the isthmus of the uterus. It is about one-quarter of an inch (0.6 centimeter) long and about one-eighth of an inch (0.3 centimeter) in diameter. The longitudinal limbs of the *arbor vitæ* extend to its upper end. The *internal os* leads from the cervical canal to the cavity of the body of the uterus. The *cavity of the body of the uterus* is triangular, with curved sides and smooth surfaces. It is lined with a smooth mucous membrane which is firmly attached to the muscular coat with little, if any, intervening connective tissue. This membrane contains numerous tubular follicles which become enormously enlarged during pregnancy. At each of the upper angles the cavity is funnel-shaped, and ends in the opening of the corresponding Fallopian tube.

The relation of the length of the body of the uterus and that of the cervix alters after childbirth, the body being but little longer than the neck in nullipara, but forming fully two-thirds of the entire organ in those who have borne children.

The **wall of the uterus** is composed of three coats—a serous, a muscular, and a mucous.

The *serous coat* is composed of peritoneum, and covers all of the uterus with the exception of the intravaginal portion of the cervix, and the anterior surface and sides of the supravaginal portion of the cervix.

The *muscular coat* consists of three layers of fibers which become very marked in the pregnant uterus. The *outer layer* is longitudinal and sends prolongations into the round, ovarian, and sacro-uterine ligaments, and into the Fallopian tubes. The *middle layer* is composed of interlacing longitudinal and transverse fibers, some of which are continued into the muscular coat of the vagina. This layer is very thick, and contains venous plexuses. The innermost fibers form *sphincters* at the *os internum* and the orifice of the Fallopian tubes. The *internal layer* is composed of longitudinal fibers and is quite thin. Its fibers are found in the *arbor vitæ* in the cervical canal. The blood-vessels ramify through the middle layer.

The *mucous coat* lines the entire cavity of the uterus. It varies in thickness in different parts, being much thinner in the body than in the cervix. It is lined with ciliated columnar epithelium down to the external os, where a gradual transition into laminated squamous epithelium takes place. It contains the small,

tubular, utricular glands. In the cervical canal these mucous glands may become distended, and are then known as ovula Nabothi.

BLOOD SUPPLY.—The blood supply of the uterus is chiefly derived from the uterine and the ovarian arteries. A small amount is supplied through the funicular artery or artery to the round ligament, which is a branch of the superior vesical. The course of the uterine artery to its anastomosis with the ovarian artery has been described. It sends numerous branches to supply the muscle of the organ. The ovarian artery is a branch of the aorta. After crossing the brim of the pelvis, in front of either the common or external iliac artery, the ovarian artery passes inward, between the folds of the broad ligament, sending branches to the ovary, the Fallopian tube, and a terminal branch to anastomose with the uterine artery. During pregnancy the uterine artery does not increase in size to any appreciable extent. It loses its tortuous character and becomes a straight vessel which lies along the side of the uterus. During pregnancy the ovarian artery becomes much larger than the uterine.

The **veins of the uterus** form a network in the muscular coat of the organ and open into the *uterine plexus of veins* which is found along the side of the uterus. At the upper end of this plexus there is a communication with the ovarian vein, and at the lower extremity with the vaginal and vesical plexuses. Near the middle of the plexus the *uterine vein* arises. It follows the course of the uterine artery and empties into the internal iliac vein. Unlike the artery, it is not tortuous.

The **lymphatics of the uterus** consist of a superficial and a deep set. The superficial set is subperitoneal, and the deep set is found in the substance of the uterus. The lymphatics from the cervix and vagina, with the exception of those from the vaginal outlet, terminate in the internal iliac and sacral glands. Those from the body and fundus of the organ pass laterally between the layers of the broad ligament and join others from the ovaries, Fallopian tubes, and broad ligaments. They accompany the ovarian artery as far as the lumbar glands, into which they empty. The uterine lymphatics are enormously enlarged during gestation.

NERVE SUPPLY.—The nerve supply of the uterus is derived from the third and fourth sacral nerves and from the inferior hypogastric and ovarian sympathetic plexuses.

The **ligaments of the uterus** are of two kinds—peritoneal, or false, and fibromuscular, or true. There are three pairs of false ligaments and four pairs of true ligaments, the *true ligaments* being found between the layers of peritoneum of the false ligaments. The *peritoneal* or *false ligaments* are two anterior or vesico-uterine, two lateral or broad, and two posterior or recto-uterine.

The *vesico-uterine ligaments* are two poorly defined folds or layers of peritoneum, formed by the reflection of that membrane from the bladder to the uterus. They join the uterus at about the level of the internal os.

The *lateral* or *broad ligaments* are formed by reflection of the peritoneum from the sides of the uterus and vagina transversely outward to the pelvic walls. They somewhat resemble the wing of a bat in shape. Between the two layers of each ligament are contained the following structures: The Fallopian tube; the ovary and its ligaments; the parovarium; the duct of Gärtner, which represents the lower part of the Wolffian duct, but is seldom seen in the human subject; the hydatid of Morgagni; the uterine and ovarian vessels; the uterine plexus of nerves; extraperitoneal connective tissue; and the following ligaments of the uterus, all of which are composed of muscular tissue—namely, the round, the ovarian, and the utero-pelvic. The two layers of the broad ligament form a free margin above, but below they are reflected upon neighboring structures. Each ligament presents four borders—namely, the superior or tubal, the internal or uterine, the external or obturator, and the inferior or recto-vesical, the two latter borders being so styled because of the relation which they bear to the obturator and recto-vesical fasciæ. Each ligament presents two surfaces, an anterior and a posterior, the latter being broader vertically.

The *superior, tubal, or free border* is formed by the peritoneum in turning around the Fallopian tube. At the outer part of this border the posterior surface of the ligament is seen to form a sharp curved fold, the concavity of which is directed outward. This fold is situated between the fimbriated extremity of the Fallopian tube and the inferior or recto-vesical border, and is called the *infundibulo-pelvic ligament*, which transmits the ovarian vessels.

The *internal or uterine border* is attached to the side of the uterus and vagina, and gives passage to the loop between the uterine and ovarian arteries and to the uterine plexus of veins.

The *external or obturator border* lies against the obturator fascia and gives passage to the uterine vessels and round ligament.

The *inferior or recto-vesical border* is directed toward the recto-vesical fascia and levator ani muscle and contains between its layers subperitoneal connective tissue, fat, the uterine vessels and nerves, and the ureter.

The *false posterior or recto-uterine ligaments*, which are composed of peritoneum, are two single serous layers which pass backward from the posterior surface of the uterus and vagina to the upper portion of the rectum, where they are continuous with the peritoneal coat of the rectum. These folds of peritoneum form the lateral boundaries of the pouch of Douglas. External to each of these false ligaments are found the true or muscular utero-sacral ligaments, extra-

peritoneal connective tissue, and anastomosing branches of the uterine and hemorrhoidal vessels.

The *muscular* or *true ligaments of the uterus* are found in four pairs running between the folds of the peritoneal ligaments. They are the round, the utero-sacral, the utero-pelvic, and the utero-ovarian ligaments.

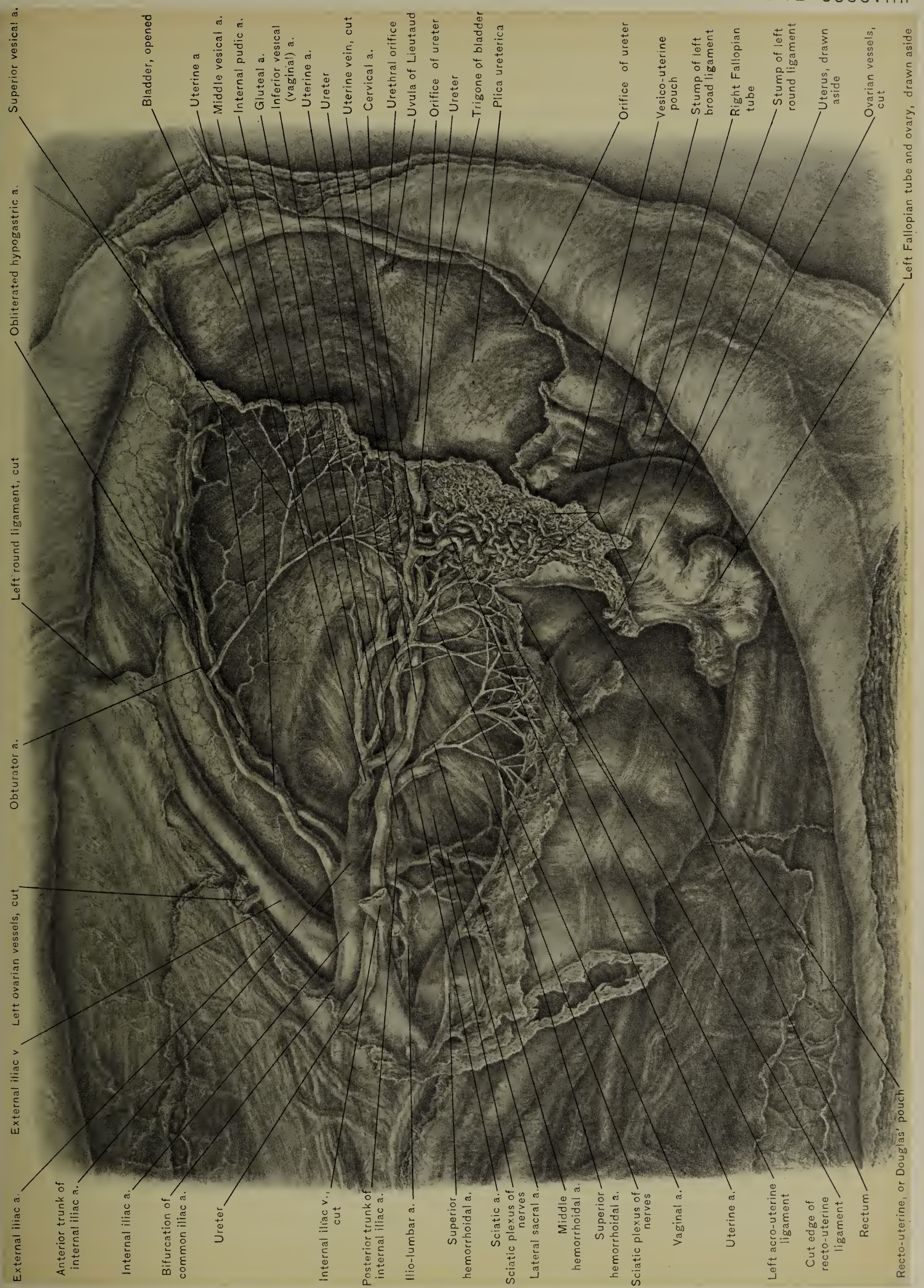
The *round ligaments* are composed of muscular and connective tissue. They extend from the sides of the uterus to which they are attached immediately below and in front of the Fallopian tubes, and describe a curve by passing upward and outward beneath the anterior layers of the broad ligaments to reach the brim of the pelvis. Each ligament then crosses the external iliac vessels and turns forward to the outer side of the deep epigastric arteries, where it passes through the internal abdominal ring to enter the inguinal canal. In the inguinal canal it is accompanied by the remains of the processus vaginalis which at times remains patulous after birth and takes the name of the *canal of Nuck*. The round ligament receives additional muscular fibers while in the inguinal canal which correspond to the cremaster muscle of the male. It gives off other muscular fibers which strengthen the external abdominal ring, after which they pass through the external ring to be lost in small fasciculi which ramify through the connective tissue of the mons veneris. The *funicular artery*, a branch of the superior vesical, and a small plexus of veins are found in the round ligament. These ligaments become relaxed in backward displacements of the uterus and are sometimes shortened in the inguinal canal (Alexander's operation) or intra-abdominally to correct these displacements.

The *utero-sacral ligaments* are flat muscular bands, which extend from the uterus at the level of the internal os, beneath the layers of the recto-uterine ligaments, to the sides of the sacrum, opposite the lower borders of the sacro-iliac articulation. In the first part of their course they are in relation with the lateral walls of the pouch of Douglas and finally run on either side of the rectum near the junction of the sigmoid flexure and the upper portion of the rectum.

The *utero-pelvic ligaments*, inclosed between the folds of the broad ligaments, are two bands of muscular fibers which pass from the pelvic fascia over the upper part of the internal obturator muscle to the sides of the uterus and vagina. They ensheathe the uterine and vaginal vessels and nerves.

The *utero-ovarian ligaments*, or *ligaments of the ovaries*, are two rounded cords which spring from the muscular tissue of the uterus near its junction with the Fallopian tubes. They pass between the layers of the broad ligaments to the attached border and inner end of the ovary.

ACTION.—The action of these various ligaments is to sustain the uterus in its



UTERUS, BROAD LIGAMENT, UTERINE ARTERY, AND URETER.

normal position and to convey to that organ its vessels and nerves, as well as to maintain the normal relations between the uterus and its appendages.

Hysterectomy.—The main anatomical points to be remembered in the removal of the uterus, either through the abdominal wall or through the vagina, are as follows: The uterus is held in place by the broad, utero-vesical, and recto-uterine peritoneal ligaments and the muscular ligaments which are found within the serous folds. The blood supply of the uterus is furnished by the ovarian and uterine arteries. The ovarian artery is found in the broad ligament just below the Fallopian tube and anastomoses, near the superior angle of the uterus, with the uterine artery. The uterine artery passes to the uterus between the two layers of the lower portion of the broad ligament, describing in its course a curve downward and backward within which is found a plexus of veins through which the ureter passes. The veins in the broad ligaments are in the form of a pampiniform plexus. The peritoneal covering of the uterus entirely surrounds that organ with the exception of the intravaginal portion of the cervix and the anterior surface of the supravaginal portion of the cervix. The vagina is attached to the cervix below the level of the internal os. In front, the uterus is closely connected with the bladder; and behind, with the rectum. Coils of small intestine are in relation with the fundus and posterior surface of the body of the uterus, and to these or the great omentum the organ may become adherent through inflammatory adhesions. The uterus is removed through the vagina, or through an incision in the abdominal walls either through the linea alba or the rectus muscle. In the operation through the linea alba of the abdominal wall the incision passes through skin, superficial fascia, the aponeurosis of the external oblique, internal oblique, and transversalis muscles blended at the linea alba, transversalis fascia, preperitoneal fat, and peritoneum. Many small vessels in the subcutaneous tissues will be severed, but their bleeding will be of no moment, as it is readily controlled. The finger is then passed into the abdominal cavity to ascertain the relations of the uterine appendages to the uterine tumor. There may be many adhesions found, and these will have to be either torn away with the finger or cut between ligatures. The method of removal of the tumor depends to a great extent upon the method to be used in treating the stump. If the stump is to be treated extraperitoneally, the mass is brought into the wound, the uterine appendages remaining attached to the sides of the uterus. Koeberle's *serre-nœud* is then passed around the pedicle which is formed by the upper portion of the cervix, the loop lying on a level with the internal os. In applying the *serre-nœud* care must be taken to avoid including the summit of the bladder in its grasp. Cases in which this has happened are on record, the bladder being opened and part of it removed with the uterus. The patients died. After the wire loop has been placed in position,

the serre-nœud pins are passed through the uterus, above the loop, and the latter is gradually tightened. The mass above the pins is then removed and the stump treated in the abdominal wound, it being held there by the pins which rest upon the abdominal walls. If the stump is to be treated intraperitoneally, the next step is to ligate the ovarian and uterine vessels. The ovarian artery will be found in the upper portion of the broad ligament. It should be tied with two ligatures at the outer side of the ovary and divided between them. The uterine artery is found between the folds of the lower portion of the broad ligament. It should be severed between two ligatures near the uterus, care being taken to avoid the ureter which passes below the broad ligament, through the plexus of uterine veins found in the loop of the uterine artery, parallel with the cervix and from one-third to three-fifths inch (0.8 to 1.5 centimeters) from it, and over the upper part of the vaginal wall to reach the bladder. The broad ligament is then to be divided by cutting between two rows of ligatures which extend in a line from the brim of the pelvis to the neck of the uterus. These ligatures must be firmly tied or there will be bleeding from the pampiniform plexus of veins found in the broad ligament. The mass is then brought into the wound and a cuff of peritoneum is reflected from the uterus beginning just above the level of the utero-vesical fold and extending to the level of the internal os. The bladder is carried forward with the anterior part of the cuff. The muscle of the uterus is then severed by a V-shaped incision and the uterus removed. There will be no hemorrhage following this step if the vessels have been properly ligated, as practically all the blood to the uterus is carried by the uterine and ovarian arteries. The stump is cleaned with an antiseptic solution, the mucous membrane of the uterine canal is sutured, the sides of the V are firmly held together by sutures, and the peritoneal cuff is brought together by a continuous suture.

In removing the entire organ through the abdomen, after having ligated the uterine and ovarian arteries and the broad ligament, a circular incision is made through the serous covering about a half inch (1.3 centimeters) above the utero-vesical fold. The attachment of the vaginal wall to the upper portion of the cervix is severed, and the cervix separated from its external mucous covering, care being taken to do all cutting and stripping close to the body of the cervix so as not to damage the ureter or bladder. The mass is then removed and the vaginal walls allowed to fall into place. Drainage, if necessary, can be had through the vagina.

In removal of the uterus through the vagina the cervix is forcibly drawn downward into the vulvar orifice and the anterior and posterior lips united by a row of sutures whose ends are allowed to remain long, being used to draw the organ downward. This suturing prevents the escape of any infectious material

from the uterus. The posterior vaginal wall is incised around the cervix and close to it, and the vaginal wall pushed away from the cervix by the finger. When the peritoneum is reached (Douglas' pouch), it is incised from side to side. The anterior vaginal wall is then incised close to the cervix to avoid injuring the bladder, ureters, or uterine arteries. Upon reaching the vesico-uterine fold of peritoneum an incision is carried through it from side to side. The cervix is thus entirely freed and the base of the broad ligaments exposed. Ligatures are then passed through the broad ligament not further than one-half inch (1.3 centimeters) from the lateral margin of the cervix, great care being taken to avoid including the ureters. To avoid this, bougies may be passed into the ureters. With scissors the broad ligament is then cut away between the ligature and the uterus, keeping close to that organ. Any bleeding points are immediately ligated. The upper portions of the broad ligament are then ligated in the same manner. The tubes and ovaries are usually ligated at their uterine side, and allowed to remain, as it is difficult to carry a ligature external to them; and, owing to the tenseness of the infundibulo-pelvic ligament, such a ligature is liable to slip from the stump and cause bleeding from the ovarian vessels. After ligating the one broad ligament, the other can be more readily dealt with, and the uterus freed and removed. A simple gauze packing may then complete the operation or the peritoneum may be stitched in a few places, partly closing the vagina above.

Instead of ligating the broad ligaments, they may be clamped by forceps. The latter are allowed to remain for thirty-six to forty-eight hours, and are then removed.

The **Vagina** is a hollow tube which extends from the vulva to the cervix uteri. Its axis forms a curve whose concavity is directed forward. It is contracted at its lower end, the *introitus vaginæ*, and widens in its ascent, becoming loose and roomy near its upper end, thus readily permitting the sweep of the examining finger around the pelvis in contact with its bony, fascial, and ligamentous walls. The vagina is a muscular tube lined with a rugous mucous membrane, and is strengthened upon its outside by condensed connective tissue. Like all tubular viscera, its wall contains longitudinal and transverse muscle-fibers, the former being superficial. The canal lies between the bladder and urethra in front, and the rectum behind. The **mucous membrane of the vagina** is arranged similar to that of the cervix, except that its crosswise rugæ or folds are transverse instead of oblique. The anterior and posterior longitudinal folds are called the *anterior* and *posterior columns*. The mucous lining is continuous with that of the cervix and vulva, and consists of squamous epithelium. The arches formed by the reflection of the wall of the vagina upon the front and back of the cervix uteri are known as the *anterior fornix* and the *posterior fornix*, the latter being much larger and deeper

because of the higher attachment of the vaginal wall on the posterior aspect of the cervix and consequent greater length of the posterior wall of the vagina. The walls of the vagina lie in contact, the anterior and posterior walls being in apposition; the anterior wall is about two and one-half inches (6.25 centimeters) and the posterior three and one-half inches (nine centimeters) in length. The direction of the vagina is upward and slightly backward. Its walls are elastic and readily elongated, for otherwise coitus would be impossible without excruciating pain and great danger of serious injury to the vagina. The inlet may be temporarily narrowed by the engorged bulbi vestibuli, or by the action of the constrictor vaginae and levator ani muscles. As the lower end of the vagina pierces the triangular ligament, the orifice is rendered quite firm and unyielding.

RELATIONS.—In front of the vagina are the urethra, the base of the bladder, and the terminations of the ureters; the vesical orifices of the ureters lying in front of the vagina and one and one-fourth inches (3.2 centimeters) below the os uteri; behind it, the perineal body, levator ani muscle, rectum, and peritoneum (cul-de-sac of Douglas); its sides give attachment to the recto-vesical fascia, levator ani muscles, and broad ligaments, and the ureters pass obliquely forward along the sides in the upper third of the vagina.

The ducts of Gärtner, fetal relics, may be found alongside the lateral wall of the vagina, in the upper half of its extent. They are thin, fibrous cords and are regarded by some authors as ending in Skene's tubes, two little orifices sometimes observed by the sides of the external urinary meatus.

BLOOD SUPPLY.—The blood supply of the vagina is very rich. The arteries which supply it are from the uterine, the vesical, the vaginal, and the internal pudic, all of which are branches of the internal iliac. The *vaginal veins* form a dense plexus which communicates with the plexuses of the uterus, bladder, rectum, broad ligament, and vulva. The blood finally reaches the internal iliac vein.

The *lymphatics of the vagina* pass to the inguinal and internal iliac glands.

NERVE SUPPLY.—The nerve supply of the vagina is derived from the pelvic plexuses of the sympathetic, the fourth sacral nerve, and the internal pudic nerve.

Atresia of the vagina is usually a congenital condition, but may be the result of injuries or surgical operations.

In the congenital variety it may be due to an imperforate hymen or to absence of the vagina in whole or in part. When the uterus and ovaries are absent, atresia of the vagina causes no symptoms. But when they are present, retention of the menstrual fluid causes trouble as soon as menstruation begins. The uterus and Fallopian tubes become distended with menstrual blood,

the latter eventually escaping into the pelvic cavity, and accumulating in Douglas' pouch.

The **Hymen** is usually a thin semilunar fold of fibrous tissue with its concavity directed upward, partly closing the vaginal orifice. It varies very much in thickness and elasticity, and may remain unbroken until parturition.

Digital examinations of the pelvic organs are readily made through the vagina, and growths and tumors thus palpated. Displacements and diseases of the uterus and adnexa, as well as effusions, can be recognized in this manner. A vermiform appendix occupying the pelvis may be palpated through the vagina.

When the pelvic floor has been injured, usually as a result of childbirth, a relaxation of the vaginal outlet takes place, and the perineal body becomes shallower owing to the tears of the sphincter ani and levator ani muscles and fasciæ. These tears may take place subcutaneously. The pelvic contents, being deprived of support, become displaced, retrodisplacement and prolapse of the uterus being the usual result. The relaxed vaginal walls, especially the posterior, bulge at the vulvar orifice, and the condition becomes known as prolapse of the vaginal walls. When the rectum is found bulging into the prolapsed posterior vaginal wall, the name *rectocele* is given to the condition. *Cystocele* is the term applied when the bladder is found in the prolapsed anterior vaginal wall. When the tear of the perineum involves the rectum, incontinence of feces ensues, and the feces will be discharged through the vagina.

Emmett devised an operation to repair the lacerated perineal structures. The crest of the prolapse or rectocele is determined first of all and the posterior surface of the vagina then denuded from the sphincter ani muscle along the labia to the lowest remains of the hymen and across to the crest of the rectocele, and from there to the opposite side, leaving a denudation of somewhat triangular shape. Sutures unite the incision on each side, extending into the sulci, and deep sutures catch the ends of the levator and sphincter ani muscles and approximate them.

To correct prolapse of the anterior vaginal wall (*cystocele*), an oval denudation is made and the side of the oval approximated by suture.

The abdominal cavity has been opened through a wound of the vagina and in several instances several feet of intestines have protruded through the vulvar orifice in consequence of such injuries. Wounds of the vagina, on account of its vascularity, may give rise to serious and even fatal hemorrhage. Owing to the thin vaginal wall between the bladder and vagina, and the rectum and vagina, the occurrence of vesico-vaginal and recto-vaginal fistulæ is not uncommon.

The **Ovaries** (*testes muliebres* of Galen) are the sexual glands of the female, and are two almond-shaped bodies having two margins, two ends, and two surfaces; they are approximately an inch and a half (four centimeters) long, one inch

(2.5 centimeters) wide, and a half inch (1.25 centimeters) thick, though varying considerably in size, and weigh about seven grams. They are usually suspended in a small secondary fold of peritoneum which is derived from the posterior surface of the broad ligaments. In the virgin the ovary lies against the lateral pelvic wall in a hollow (*fossa ovarii* of Claudius) just beneath the external iliac vessels. The direction of the long axis of the ovary in its normal position is in dispute, the authorities placing it vertically, obliquely, or horizontally, with varying lateral deviations to or from the mesial plane. The truth probably is that this very movable organ may occupy any of these positions, maintaining that one which it happens to assume early in life until it is displaced by pregnancy, after which it seldom, if ever, returns exactly to its original place. The surfaces usually face inward and outward, while the borders are directed forward and backward.

The **anterior border** is less curved than the posterior, and is thinner. Here is where the vessels and nerves enter and leave it, and where the peritoneal layers unite, thus giving rise to the term *attached margin*.

The **posterior border** is free and rounded, and enveloped by peritoneum, the entire ovary having the appearance of being hung upon the back of the broad ligament by its anterior edge.

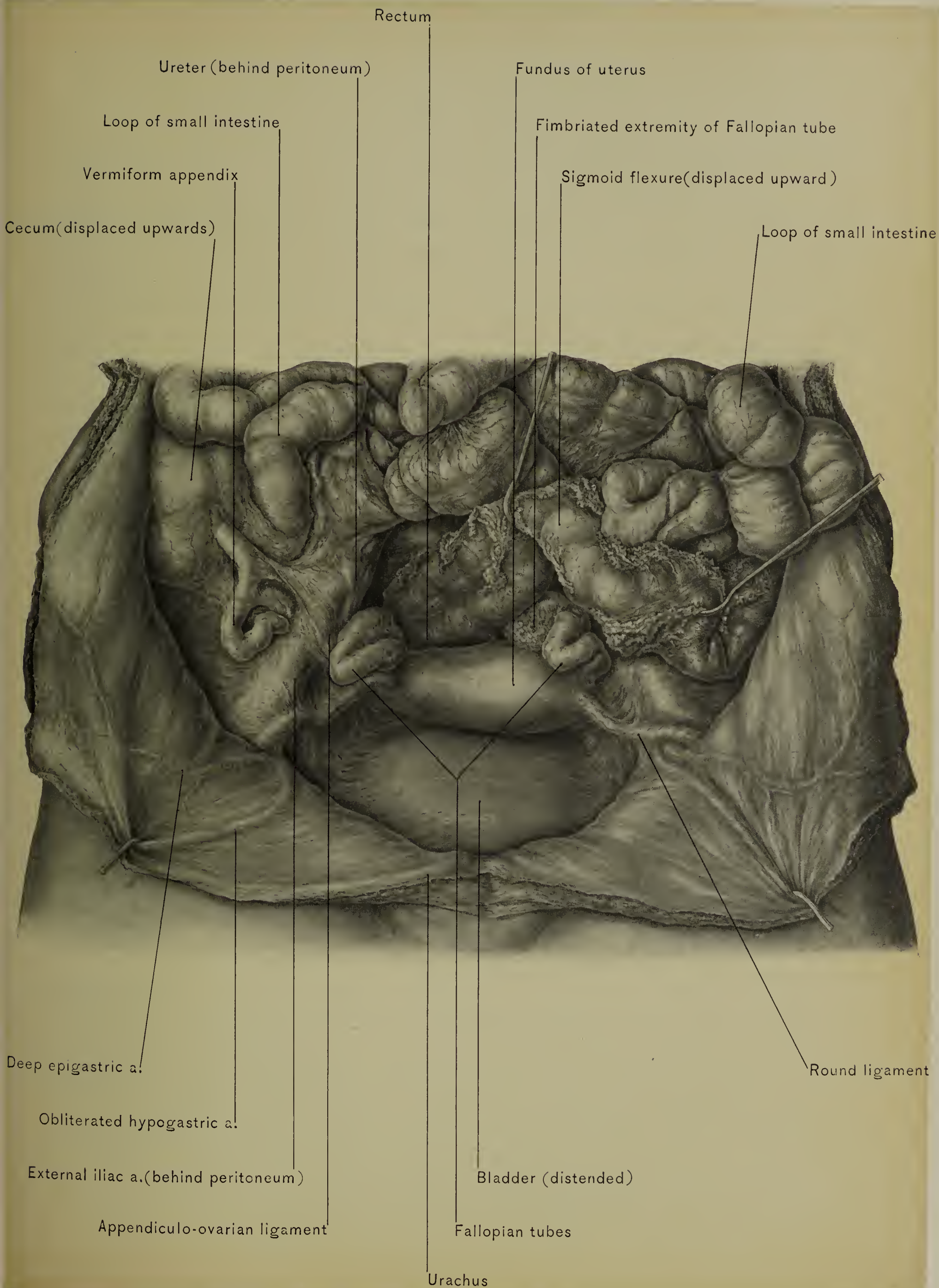
The ends of the ovary are called poles, tubal and uterine. The **upper** or **tubal pole** is connected with the fimbriated extremity of the Fallopian tube by one of its fimbriæ, and has passing from it a peritoneal fold (ovario-pelvic or infundibulo-pelvic ligament) to the lateral pelvic wall. The **lower** or **uterine pole** is connected with the uterus by a round cord, called the *utero-ovarian ligament*, which is attached to the side of the body of the uterus between the Fallopian tube and round ligament.

The **surface of the ovary** is smooth before puberty, but after this period it becomes more uneven with advancing age, because of the pitting due to scars (*corpora lutea*) following the periodical rupture of Graafian vesicles.

The **vessels and nerves of the ovary** enter the organ through the *hilum*, which is found on the anterior border.

BLOOD SUPPLY.—The blood supply of the ovary is derived from the ovarian artery. This artery takes a tortuous course; its walls are thick and its caliber narrow. The veins empty into the plexus found in the broad ligament, the blood from which empties largely into the ovarian vein; the left vein then empties into the renal vein at right angles, its opening being free from any valve. The right vein empties into the inferior vena cava, its opening being protected by a valve; in this respect the ovarian veins are similar to the spermatic veins in the male.

The *lymphatics of the ovary* empty into the lumbar glands.



PELVIC CAVITY OF FEMALE—SUPERIOR VIEW.

NERVE SUPPLY.—The nerve supply of the ovary is derived from the ovarian plexus of the sympathetic and from the uterine nerves.

The **Parovarium** (*organ of Rosenmüller, female epididymis*) lies in the broad ligament, between the ovary and the tube, and consists of numerous divergent tubules beginning close to the anterior or attached margin of the ovary and extending thence toward the Fallopian tube, where they join a large longitudinal tube. It is best seen by transmitted light and is readily overlooked. It is formed by part of the Wolffian body of the embryo.

The **Fallopian Tubes**, or **Oviducts**, are two trumpet-shaped tubes which pass from the superior angles of the uterus to the ovaries in the upper or free margins of the broad ligaments. Their cavities are continuous with the cavity of the uterus, and thus form a passageway between the exterior and the peritoneal cavity. Generally, however, this channel is closed at the ovarian end on account of the close proximity of the ovary to the fimbriated end of the tube. The tubes are about four inches (ten centimeters) long. Near the uterine end the tube is straight and narrow, but widens toward the middle and becomes somewhat tortuous, and finally ends in a trumpet-shaped extremity which is fringed with a circle of *fimbriæ*. One of these fimbriæ is attached to the upper extremity of the ovary, and takes the name of the **tubo-ovarian ligament**, or the **ovarian fimbria**. The narrow, uterine end is known as the **isthmus of the tube**, the widened central portion as the **ampulla**, and the trumpet-shaped end as the **fimbriated extremity**. The width of the tubes varies from about an eighth of an inch (0.3 centimeter) at the uterine end to about three-fifths of an inch (1.5 centimeters) at the ovarian end, the fimbriæ often forming an expansion of about one inch (2.5 centimeters).

The Fallopian tubes have four coats—serous, fibrous, muscular, and mucous.

The *serous coat* is incomplete, the muscular coat being uncovered along a portion of its circumference where the folds of the broad ligament are attached. This fact explains why the tube may rupture into the interserous space of the broad ligament or into the general peritoneal cavity.

The *fibrous coat* is continuous with the extraperitoneal connective tissue of the broad ligament; it is very rich in vessels.

The *muscular coat* consists of circular and longitudinal layers, the latter being external to the former.

The *mucous coat* is thrown into longitudinal folds. These are very simple in the isthmus, but become quite complicated in the ampulla. They generally end in the fimbriæ.

BLOOD SUPPLY.—The blood supply of the Fallopian tubes is furnished by branches from the ovarian arteries. The veins empty into the venous plexus found in the broad ligament.

The *lymphatics* empty into those of the ovary, finally being carried to the lumbar glands.

NERVE SUPPLY.—The nerve supply of the Fallopian tubes is derived from the pelvic plexuses of the sympathetic.

Removal of the ovary and tube.—The anatomical points to be remembered when performing the operation for the removal of the ovaries and tubes are as follows: The ovary is connected to the broad ligament by its attached or anterior margin, through which the vessels and nerves pass to the organ. The ovary is attached to the uterus by the utero-ovarian ligament, a prolongation of the muscle substance of the uterus, and is connected to the fimbriated extremity of the Fallopian tube by the ovarian fimbria, or tubo-ovarian ligament. The blood supply of the ovary is obtained from the ovarian artery, a branch of the aorta. The Fallopian tube is a trumpet-shaped tube which extends from the superior angle of the uterus, along the free border of the broad ligament, to a point a short distance external to the ovary. Its canal is continuous with that of the uterus, and opens into the general peritoneal cavity. It is supplied by branches from the ovarian and uterine arteries. The ovarian artery enters the broad ligament from the pelvic brim and passes between the folds of the ligament, beneath the Fallopian tube, to the upper part of the body of the uterus, where it anastomoses with the uterine artery. It sends numerous branches to the ovary and Fallopian tube. The ovarian vein has the same general course as the ovarian artery. In the broad ligament near the ovary it forms a plexus which communicates with the plexus of the uterine veins. The peritoneum is reflected from the pelvic walls to the uterus as the broad ligament, the free border of which immediately surrounds the Fallopian tube.

In the operation of **ovariectomy** the incision in the abdominal wall passes through the skin, superficial fascia, the aponeurosis of the external oblique, internal oblique, and transversalis muscles blended at the linea alba, transversalis fascia, preperitoneal fat, and peritoneum. The operation can also be done through either rectus abdominis muscle. The ovary is located by following the dorsal surface of the bladder into the utero-vesical pouch and tracing the broad ligament from the side of the uterus to the ovary. The uterus is recognized by its consistence and shape and by its position between the two broad ligaments. The Fallopian tube is felt as a cord-like structure in the free margin of the broad ligament. Any adhesions which may have formed must be treated either by breaking them up with the finger, or by tying off and cutting them, and the ovary and tube are brought into the abdominal wound if possible. The pedicle will be seen to consist of a band of peritoneum—the broad ligament—which transmits the Fallopian tube, the utero-ovarian ligament, and the round liga-

ment of the uterus. An elevated ridge is seen running along the posterior surface of the broad ligament and is formed by the ovarian artery and the pampiniform plexus of veins. In order to securely tie all of these structures it is advisable to transfix the pedicle with a double ligature the two halves of which will secure the two portions of the pedicle. The stump is returned to the abdominal cavity and the wound closed.

The **Female Bladder** is situated between the bodies of the pubic bones in front, and the uterus and vagina behind. It is smaller than that of the male in the antero-posterior diameter, but is much broader at the base. With the exception of its attachment to the vagina and cervix uteri instead of the rectum, and the absence of the prostate, the female bladder has practically the same connections as the male. The interior of the organ is the same as that of the male, but as the urethra is shorter and more dilatable, the ureters are more accessible in the female; and since the symphysis pubis is less deep in the female, the urethral orifice lies nearer its lower border. The openings of the ureters lie at the outer or basal angles of the vesical trigone; the line connecting them forms the base of this triangular space, and the apex is at the internal urinary meatus or vesical opening of the urethra. A fold of mucous membrane running from the orifice of the urethra to that of the ureter, and which can be indistinctly felt through the vaginal wall, acts as a guide by which a catheter may be passed into the ureter. While a catheter can be guided into the ureter simply by the sense of touch, it can be more readily introduced by employing a urethral speculum and exposing the urethral orifice by an electric light (cystoscope).

BLOOD SUPPLY.—The blood supply of the female bladder is the same as that of the male bladder, with the exception that small branches from the uterine and vaginal arteries carry blood to it. The veins form plexuses which join those of the uterus, rectum, and vagina, and finally empty into the internal iliac vein.

The *lymphatics* empty into the pelvic glands.

NERVE SUPPLY.—The nerve supply of the female bladder is derived from the third and fourth sacral nerves and the pelvic plexuses of the sympathetic.

The **Female Urethra** is about one and a half inches (four centimeters) in length, and is slightly curved, with its convexity downward and backward. It really represents only the upper part of the male urethra. It may be divided into three portions: The pelvic, that portion between the bladder and the triangular ligament; the membranous, between the layers of the triangular ligament; and the vaginal, between the triangular ligament and the meatus, this portion running in the upper part of the wall of the vagina, where it is surrounded by a plexus of veins (plexus of Santorini). The female urethra is flaccid and collapsed when empty, and is capable of great dilatation.

The BLOOD SUPPLY and NERVE SUPPLY of the female urethra are derived from the vessels and nerves of the vagina.

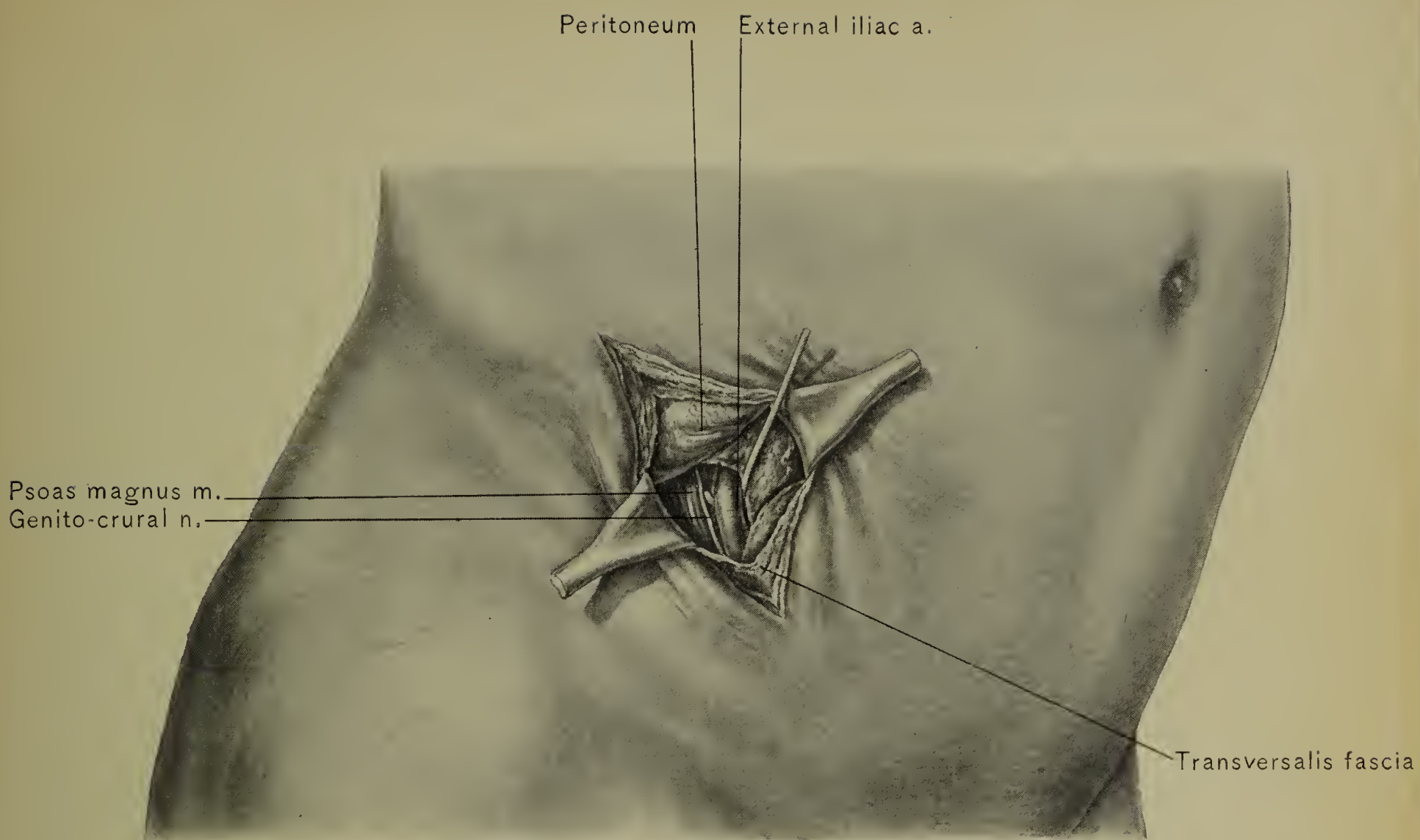
In *ligation* of the external iliac artery, which operation may be required in aneurysm or wounds of the vessel, two methods may be employed: viz., the extra-peritoneal, and the intra- or transperitoneal. The upper and lower portions of the vessel are usually avoided owing to the proximity of the internal iliac artery above and the deep epigastric and deep circumflex iliac below.

In the former operation an incision is made, beginning three-fourths of an inch (1.9 centimeters) above Poupart's ligament and a little external to its midpoint and parallel to it, to a point opposite the anterior superior iliac spine. If the artery is deeply seated, this incision should be made curved with its convexity downward and outward, to gain more room. After cutting through the abdominal muscles the peritoneum should be pushed upward and inward from the iliac fossa till the vessel is reached. The needle is then passed from within outward, care being taken to avoid injuring the vein.

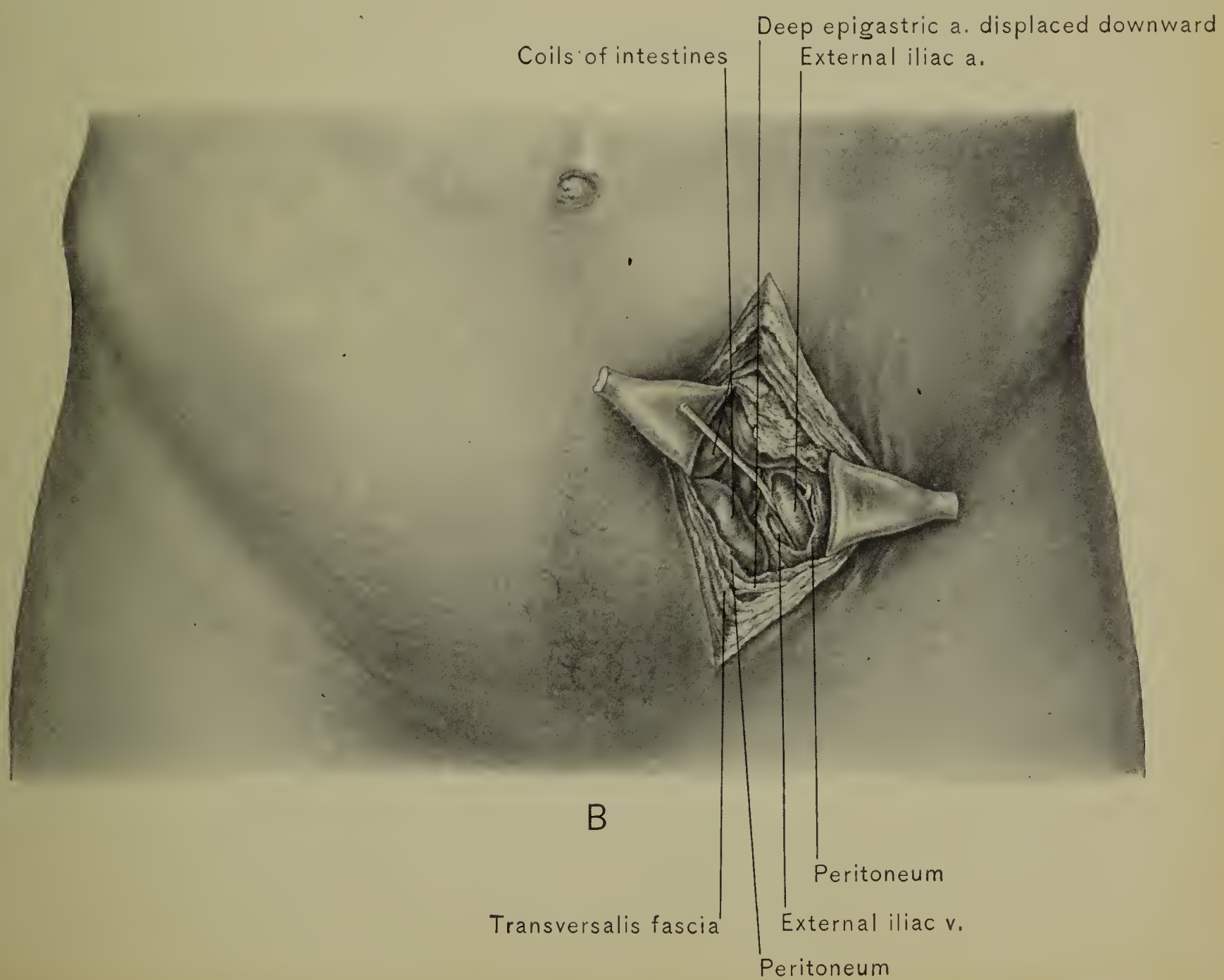
In the intra- or transperitoneal method the incision is made either in the semilunar line or through the rectus abdominis muscle, beginning about an inch (2.5 centimeters) below the level of the umbilicus and extending it downward for about four inches (ten centimeters). After the peritoneal cavity is opened the intestines are displaced and the peritoneum over the artery incised parallel to the vessel and the latter exposed. A ligature is then passed from within outward. The advantage of this operation over the other is that the vessel may be tied in any part of its course that seems desirable; and that the common iliac artery may be ligated through the same incision if it were required instead.

The **Muscles within the Pelvis** are the levator ani, the coccygeus, and the obturator internus.

The **levator ani muscle** arises from the posterior surface of the body of the pubis, the spine of the ischium, and from the white line or lower border of the pelvic fascia in the interval formed by the divergence of the recto-vesical and obturator fasciæ. The fibers of the muscle may be divided into three sets. The anterior fibers pass along the sides of the prostate in the male and the vagina in the female and meet the corresponding fibers of the opposite levator ani muscle in the interval between the rectum and the prostate or vagina, where they are inserted into the central tendon of the perineum; the middle fibers blend with the longitudinal fibers of the rectum and the external sphincter ani; the posterior fibers are divided into those which join with corresponding fibers of the other levator ani muscle to form the median recto-coccygeal fibrous raphe, and those that are inserted into the tip of the coccyx. The nerve supply of the levator ani muscle is derived from the inferior hemorrhoidal nerve and the



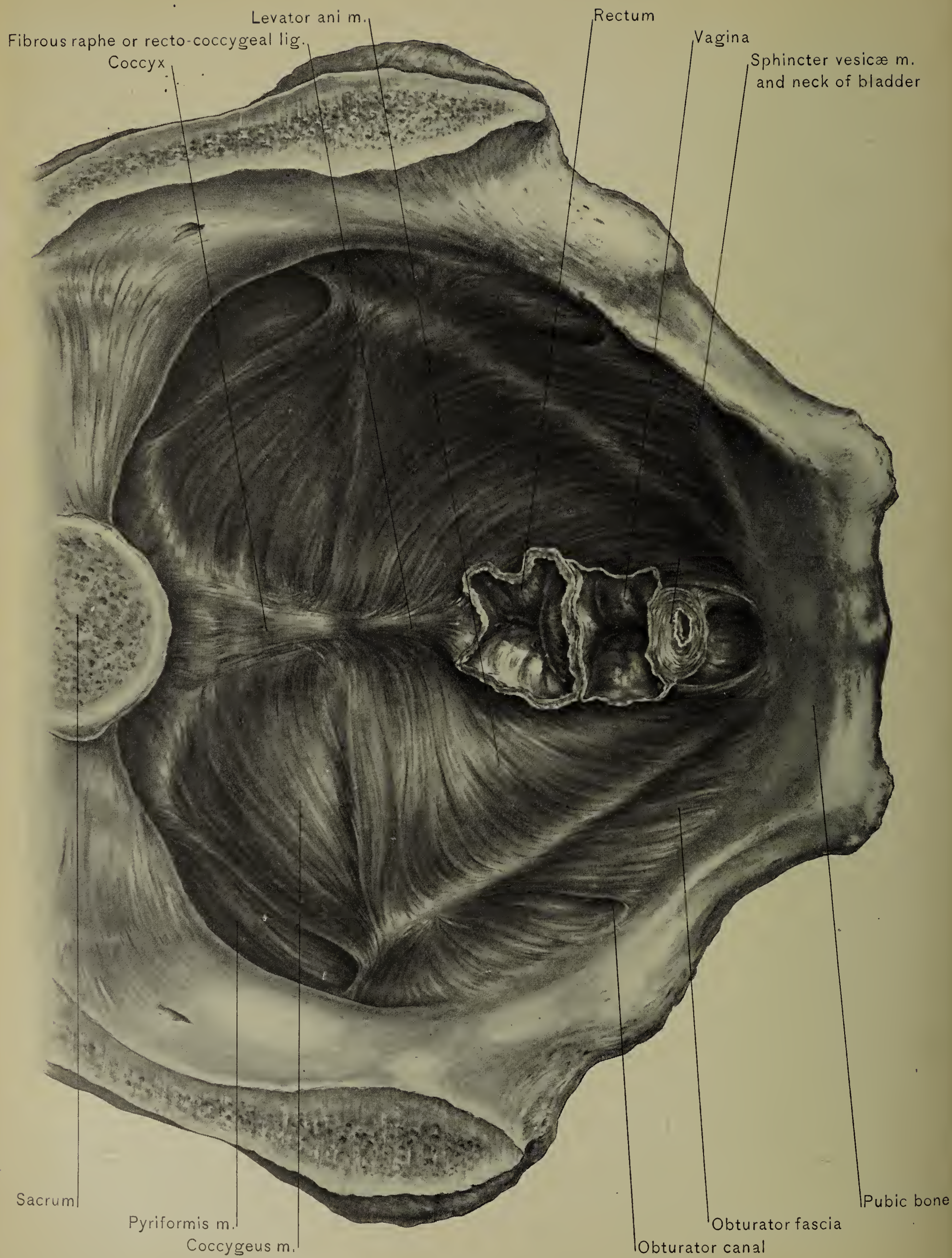
A



B

LIGATION OF EXTERNAL ILIAC ARTERY.

(A) EXTRAPERITONEAL METHOD. (B) TRANSPERITONEAL METHOD.



MUSCLES IN FLOOR OF PELVIS—SUPERIOR VIEW.

fourth and fifth sacral nerves. This muscle is more fully described with the perineum.

The **coccygeus muscle** is a small triangular muscle that is supported externally by the sacro-sciatic ligament, with which it blends. It arises from the spine of the ischium immediately above the origin of the levator ani muscle, and is inserted into the side of the coccyx, the lateral sacro-coccygeal ligament, and the last two sacral vertebræ. At times the muscle will be seen to be pierced by branches from the fourth and fifth sacral nerves and the coccygeal nerve which form a plexus on its pelvic surface.

NERVE SUPPLY.—The nerve supply of the coccygeus muscle is derived from the fourth and fifth sacral nerves and the coccygeal nerve.

ACTION.—Its action is to pull the coccyx forward.

The **obturator internus muscle** arises from the part of the internal surface of the walls of the pelvis which is formed by the obturator membrane and the bone around it—namely, from the internal surface of the body of the pubis, the descending ramus of the pubis, the ascending ramus of the ischium, from the innominate bone between the great sacro-sciatic notch and obturator foramen, the whole of the inner surface of the obturator membrane, and the outer surface of the obturator and pelvic fasciæ. Its origin is limited above by the brim of the pelvis. Its fibers end in a strong tendon which forms a right angle as it turns around the anterior margin of the lesser sacro-sciatic foramen, through which it passes to be inserted into the inner side of the upper portion of the great trochanter of the femur. The tendinous expansion of this muscle, into which the fibers converge, is corrugated into four or five folds which fit into corresponding depressions in the cartilage surrounding the lesser sacro-sciatic foramen. A bursal sac is generally found between the tendon and cartilage. The superior and inferior gemelli muscles are inserted into the tendon of this muscle. These will be described with the gluteal region.

BLOOD SUPPLY.—The blood supply of the obturator internus is chiefly derived from the obturator artery.

NERVE SUPPLY.—The nerve supply of the obturator internus muscle is derived from the first and second sacral nerves.

ACTION.—The action of the obturator internus is to rotate the femur outward.

THE LYMPHATICS OF THE ABDOMEN AND PELVIS.

The **Lymphatics of the Abdomen and Pelvis** may be divided into the *parietal*, ramifying in the abdominal and pelvic walls, and the *visceral*, which drain the abdominal and pelvic viscera.

The **parietal lymphatic vessels** may be subdivided into a superficial and a deep set; the superficial running in the skin and subcutaneous tissues, including those in the skin and subcutaneous tissue of the external genitalia, and ending for the most part in the superficial inguinal glands; the deep accompanying the deep arteries in the abdominal and pelvic parietes and emptying into the lumbar glands.

The *superficial lymphatics of the abdominal walls* ramify in the superficial fascia and follow the course of the blood-vessels situated therein. Those of the anterior abdominal wall below the level of the umbilicus follow the superficial epigastric vessels and terminate in the superior set of inguinal glands, whereas those above the level of the umbilicus pass upward to the axillary glands. Some of the superficial lymphatics of the lateral portion of the abdominal wall follow the superficial circumflex iliac artery and enter the superior set of inguinal glands, and others follow the lumbar and ilio-lumbar arteries and enter the lumbar glands.

The *superficial lymphatics of the penis* begin in the prepuce, encircle the corona and there receive the lymphatics from the anterior two-thirds of the urethra, and pass along the dorsum and side of that organ under the skin to its root, to be equally distributed to the innermost superficial inguinal glands on each side. The deep lymphatics of the penis pass along the dorsal vein to the lymphatic gland along the internal iliac artery.

The lymphatics of the scrotum in the male and those of the external generative organs of the female run to the superficial inguinal lymphatic glands. Those from the testicle pass along the spermatic artery to the lumbar glands. Therefore in carcinoma of the testicle the inguinal glands do not show enlargement until the scrotum is attacked, the lumbar glands being the ones primarily involved.

The *deep lymphatics of the anterior and lateral abdominal walls* follow the deeper blood-vessels. Those of the upper anterior part follow the superior epigastric artery and enter the internal mammary glands, the efferent vessels of which enter the anterior mediastinal glands. The deep lymphatics of the upper lateral part follow the anterior intercostal and musculo-phrenic arteries and terminate in the internal mammary lymphatic glands. Those of the lower anterior part of the abdominal wall follow the deep epigastric and deep circumflex iliac arteries and terminate in the external iliac glands, and other deep lymphatics

from the lateral abdominal wall follow the lumbar and ilio-lumbar arteries and join the lumbar glands.

The *superficial lymphatics of the pelvic walls* are those of the gluteal region, perineum, and upper part of the thigh. They empty into the superficial inguinal glands.

The *deep lymphatics of the pelvic walls* accompany the obturator, gluteal, sciatic, internal pudic, and sacral arteries. They terminate in the internal iliac and sacral glands.

The *lymphatic glands of the abdominal and pelvic walls* may be divided into the superficial and the deep.

The *superficial* set of abdominal parietal glands are the superior set of the superficial inguinal glands or oblique inguinal glands, or inguinal glands proper, situated above Poupart's ligament. These glands receive the superficial lymphatics from the penis and scrotum and the anterior two-thirds of the urethra in the male, and from the external genitalia of the female and the lower part of the vagina. Toxins and germs transmitted along the lymphatic vessels in venereal disease of the integuments of penis or pudenda or wall of the anterior two-thirds of the urethra cause inflammation and enlargements of the oblique glands, called *buboes*. These glands also become enlarged in malignant disease of the external genitalia. Their efferent vessels enter the pelvis beneath Poupart's ligament, pass through the external iliac glands, to end in the lumbar glands. They receive the deep epigastric, deep circumflex iliac, and ilio-lumbar lymphatics.

There are no superficial parietal pelvic lymphatic glands.

The *deep lymphatic glands of the abdomen and pelvis* are situated chiefly along the posterior wall of the general abdominal cavity, and from their relations with neighboring structures are described as external iliac, internal iliac, sacral, lumbar, and celiac glands.

The *external iliac glands* lie along the external and common iliac vessels, and are five or six in number. They receive the lymphatic vessels from the inguinal and femoral glands, those from the lower abdominal wall which accompany the deep epigastric and deep circumflex iliac vessels, and some of the efferent lymphatics from the internal iliac glands. Their efferent vessels terminate in the lumbar glands. They communicate with the internal iliac glands.

The *internal iliac glands* are located in the pelvic cavity along the course of the internal iliac artery and its branches, and are about ten or twelve in number. Their afferent vessels accompany the branches of the internal iliac artery and tributaries of the internal iliac vein. Therefore they receive the deep lymphatic vessels from the pelvic walls, nearly all the lymphatics from the pelvic viscera,

the deep lymphatics from the penis or clitoris, perineum, posterior part of the scrotum or labia majora, and posterior part of the urethra, the deep lymphatics of the gluteal region, and those lymphatics from the uppermost part of the thigh which drain the tissues supplied by the obturator artery. Their efferent vessels join the lumbar glands.

The *sacral glands* are found in the extraperitoneal fat in front of the sacrum, four or five being located in the lower part of the meso-sigmoid opposite the promontory of the sacrum. They receive the lymphatics from the rectum and posterior wall of the pelvis, and their efferent vessels join the lumbar glands.

The *lumbar glands* are divided into three chains—a median and two lateral.

The *median chain of lumbar glands (aortic lumbar glands)* is situated in the extraperitoneal fat along the abdominal aorta and inferior vena cava. It is composed of six or seven glands which extend from the bifurcation of the aorta to the second lumbar vertebra. They receive the efferent vessels from the external iliac, internal iliac, and sacral glands, the lymphatics from the testicles or ovaries, kidneys, suprarenal bodies, and posterior portion of the diaphragm, and some of the efferent vessels from the lateral chains of lumbar glands. Their efferent vessels usually unite to form a *right and left lumbar lymphatic trunk*, which with small efferent vessels from the lateral chains empty into the receptaculum chyli. The left lumbar trunk receives the lymphatics from the lower half of the descending colon and sigmoid flexure.

The *lateral chains of lumbar glands, transverse lumbar or psoas glands*, are placed behind the psoas muscles between the transverse processes of the lumbar vertebræ. The glands composing these chains are smaller than the glands of the median chain and are twenty or more in number. They receive the lymphatics which accompany the lumbar arteries and their branches from the spinal canal, lumbar region of the back of the trunk, and lateral and posterior abdominal walls. Some of their efferents terminate in the lumbar glands of the median chain, and the others empty into the receptaculum chyli.

The *celiac glands* are situated in front of the abdominal aorta around the celiac axis above the origin of the superior mesenteric artery. They are about fifteen in number and receive the lymphatics from the hepatic and superior gastric, inferior gastric, splenic, and pancreatic glands. Their efferent vessels terminate in the intestinal lymphatic trunk and receptaculum chyli.

The **visceral lymphatic glands** of the general abdominal cavity are the hepatic, superior gastric, inferior gastric, mesenteric, meso-colic, and splenic glands.

The *hepatic lymphatic glands* are located between the layers of the lesser omentum in front of the portal vein. They receive those deep lymphatics from the interior of the liver which accompany the radicles of the portal vein, the

superficial lymphatics from the anterior portion of the superior surface of the liver, most of the superficial lymphatics from the inferior surface of that organ, and the lymphatics from the gall-bladder. Their efferent vessels terminate in the celiac glands.

The *superior gastric lymphatic glands* are placed between the layers of the lesser omentum along the lesser curvature of the stomach. They receive the superior gastric lymphatics which follow the branches of the pyloric and gastric arteries. Their efferent vessels follow the gastric artery and vein to the left end of the lesser curvature, and there receive some lymphatics from the left lobe of the liver which follow the hepatic branch of the gastric artery. From the left side of the lesser omentum they follow the gastric artery and vein between the layers of the gastro-phrenic ligament and behind the lesser peritoneal cavity and terminate in the celiac glands.

The *inferior gastric* or *gastro-epiploic lymphatic glands* are situated between the layers of the great omentum along the gastro-epiploic vessels and greater curvature of the stomach. They are six or eight in number and receive the lymphatics from the lower part of the stomach; *i. e.*, that part supplied by the branches of the gastro-epiploic arteries. Their efferent vessels pass from left to right, are joined by the lymphatics from the upper part of the duodenum, and run between the pancreas and pylorus of the stomach to terminate in the celiac glands.

The *mesenteric lymphatic glands* are situated in the extraperitoneal connective tissue between the layers of the mesentery, and number about one hundred and fifty. They are arranged in two groups. The glands of the larger group are in relation with the vasa intestini tenuis and their anastomosing branches, and are seldom nearer than one and one-half inches (four centimeters) from the intestine except at the lower part of the ileum. They receive the lymphatics from the jejunum and ileum and their efferent vessels terminate in the glands of the second group which are much larger. The other group of mesenteric glands lies along the superior mesenteric vessels. Their efferent vessels empty into the receptaculum chyli by means of a common trunk (*intestinal lymphatic trunk*) or may empty by means of three or more trunks. The intestinal lymphatic trunk is joined by the efferent vessels of the meso-colic glands and some of those from the celiac glands.

The *meso-colic lymphatic glands* are about thirty in number and are situated in the extraperitoneal fat in relation with the colic arteries and their anastomosing loops. They receive the lymphatics from the vermiform appendix, cecum, ascending colon, transverse colon, and upper part of the descending colon. Their efferent vessels terminate in the efferent vessels of the group of mesenteric glands situated along the superior mesenteric vessels. A group of these glands found in the

angle between the ileum and ascending colon is called the *ileo-colic chain of glands*.

The *splenic glands* are about ten in number, and are situated along the splenic vessels. They receive the lymphatics from that part of the cardiac end of the stomach supplied by the vasa brevia, and the lymphatics from the spleen and pancreas. Their efferent vessels join the celiac glands.

THE THORAX.

The **Thorax** resembles in shape a truncated cone, flattened in front and behind, but rounded laterally. The right side is usually the larger, owing to the more frequent use of the right hand. The thorax is bounded in front by the sternum and costal cartilages; on either side, by the shafts of the ribs; behind, by the bodies of the thoracic or dorsal vertebræ, and the intervertebral discs and the heads and necks of the ribs. The intervals between the ribs are called the intercostal spaces and are closed by the external and internal intercostal muscles. The anterior thoracic wall is shorter than the posterior, the upper margin of the sternum, after expiration, being on a level with the cartilage between the second and third dorsal vertebræ, while the lower end of the gladiolus of the sternum is on a plane with the middle of the ninth dorsal vertebra.

The thorax has a **superior** and an **inferior opening**; a **vertical**, a **transverse**, and an **antero-posterior diameter**. In a plane passing through its transverse and antero-posterior diameter it is cordiform, or "heart-shaped." The forward projection of the bodies of the dorsal vertebræ greatly diminishes the antero-posterior diameter of the thorax in the mesial plane, but to either side of the spinal column a deep hollow is formed by the backward, outward, and finally forward curve of the ribs. This hollow accommodates the thick portion of the lungs. The antero-posterior diameter is much increased in Pott's disease, involving the dorsal spine, since by the bending and shortening of the spinal column, consequent upon this disease, the sternum is protruded and bent.

The **superior opening of the thorax**, or **inlet**, is much smaller than the inferior, or **outlet**; its antero-posterior diameter being about two and one-fourth inches (5.7 centimeters). It is bounded in front by the sternum and first costal

cartilage; behind, by the body of the first dorsal vertebra and the head and neck of the first rib; on either side, by the first rib. The plane of this opening slopes obliquely from behind forward. It is closed by the structures which pass through it—namely, the sterno-hyoid, sterno-thyroid, and longus colli muscles; the innominate and inferior thyroid veins; the left recurrent laryngeal nerve, the phrenic and pneumogastric, and the gangliated cords of the sympathetic nerves, the cervical cardiac branches of the pneumogastric and sympathetic nerves and the anterior branch of the first dorsal nerve; the innominate, left common carotid, left subclavian, internal mammary, and superior intercostal arteries, and the middle thyroid artery, when present; the thymus gland, or its shrunken remains; the esophagus, trachea, pleura, apices of the lungs, and thoracic duct; and the lamella of deep cervical fascia which lies upon the trachea, and is continuous with the fibrous layer of the pericardium.

The **inferior opening**, or **outlet**, is much wider than the superior and is bounded in front by the ensiform cartilage of the sternum; behind, by the body of the twelfth dorsal vertebra and the head and neck of the last rib; on either side, by the twelfth rib and part of the eleventh. The margin of the inferior opening extends at first outward and downward and backward along the lower costal margin to the tip of the eleventh rib. From there it passes upward, backward, and inward along the last rib to the vertebral column. Its antero-posterior diameter is about five and three-eighths inches (14.25 centimeters). It is occluded by the diaphragm, the arched floor of the chest, which divides the thoracic from the abdominal cavities, and by the structures which pass through the diaphragm. The structures piercing the diaphragm are as follows: through the esophageal opening, the esophagus, pneumogastric nerves, and esophageal arteries; through the caval opening, or foramen quadratum, the inferior vena cava; through the aortic opening, the aorta, thoracic duct, vena azygos major, and occasionally the left sympathetic nerve; through either crus, the three splanchnic nerves and the sympathetic trunk; through the left crus also, the vena azygos minor.

According to Holden, the diameters of the chest at different levels in the average male skeleton are as follows: The **antero-posterior diameter**, at the inlet, is two and one-fourth inches (5.7 centimeters); at the junction of the malleolus and gladiolus, four and one-half inches (11.2 centimeters); and at the outlet, five and three-eighths inches (14.25 centimeters). The **transverse diameter** at the inlet measures four and three-eighths inches (11 centimeters); between the second ribs, seven inches (17.5 centimeters); between the third ribs, eight and one-eighth inches (20.3 centimeters); gradually increasing between

the succeeding ribs, it attains its maximum between the ninth ribs, where it measures ten and five-eighths inches (26.6 centimeters); and gradually diminishes below that level. The **vertical diameter of the chest** is increased by the contraction and descent of the diaphragm which depresses the abdominal contents and pushes the abdominal wall outward. Expansion of the chest in its antero-posterior and transverse diameters is caused by elevation and outward rotation of the ribs. If, on measuring the circumference of the chest at the level of the nipple, a maximum expansion on inspiration of three inches (7.5 centimeters) is found, it is considered good. By bringing into action the accessory muscles of respiration, the expansion of ordinary respiration, which varies from one and one-fourth (3.2 centimeters) to two inches (5.1 centimeters), can be almost doubled.

The **female thorax** differs from that of the male in having a smaller capacity, a shorter sternum, a superior opening which is larger in proportion to the inferior, and more movable upper ribs. This greater mobility of the upper ribs in women is partly due to the compression of the lower ribs and the upper part of the abdomen by corsets. This freedom of movement in the upper chest is of advantage in advanced pregnancy, when the enlarged uterus restricts the descent of the diaphragm. The female thorax also differs from that of the male in having larger mammary glands attached to it. In the virgin the mammæ are firm, and, unsupported by stays, project from the chest-wall. Those of the woman who has borne and suckled children are flaccid and pendent.

Among the various forms of the chest may be mentioned the normal, flat, "barrel-shaped," and "pigeon-breasted."

In the **normal chest** the antero-posterior diameter is considerably shorter than the transverse, the ribs slope downward and forward, and the subcostal angle is about equivalent to a right angle.

The **flat chest** has a short antero-posterior and a comparatively long transverse diameter. The ribs slope downward and forward much more than in the normal chest, and the subcostal angle is less than a right angle. It is hereditary, and is especially seen in persons predisposed to pulmonary tuberculosis; although a person with a flat chest need not necessarily become tuberculous.

The "**barrel-shaped**" chest is short and round. Its antero-posterior diameter is nearly as long as its transverse diameter. The ribs are almost horizontal; and the subcostal angle is greater than a right angle. It is the result of emphysema.

"**Pigeon-breast**" is a term applied to a chest of which the sternum and

costal cartilages project forward beyond the ends of the ribs. The antero-posterior diameter is long, and the transverse is short. It is one of the results of rachitis, or rickets. In these cases there is usually a thickening at the junction of the ribs with their cartilages; a beaded appearance is thus produced, and the term "rachitic rosary" has been applied to the condition. Shaw gives the following explanation of this deformity: "When an inspiration is taken, a threatened vacuum is created within the chest, air rushes in by atmospheric pressure, and at the end of the inspiration the balance of pressure without the chest and within it are equalized. If in inspiration there is an impediment to the entrance of air, the atmospheric pressure upon the external wall of the chest must produce some effect, being unbalanced by a like pressure upon the inner chest-wall. In children, and especially in rickety children, the thorax is very pliable and elastic, and if a constant impediment exists to the entrance of air, as afforded, for example, by greatly enlarged tonsils, the thoracic walls may yield in time to the unbalanced pressure brought to bear upon them at each inspiration. The weakest part of the thorax is along the costo-chondral line on either side, and it is here that the parietes yield most conspicuously in such cases, and by this yielding the deformity is produced." (Treves.)

The "barrel-shaped" or emphysematous chest is irremediable, as it is due to permanent distention of the air vesicles of the lungs. In young individuals both the flat and "pigeon-breasted" chests may be much improved by suitable gymnastic exercises.

Unilateral changes may also be found. A pleural effusion of fluid or air; tumors, as sarcoma of the lung; or extensive pneumonia will cause greater or less bulging of the affected side. Retraction of one side may be brought about by phthisis, or abscess, followed by cicatrization and contraction of the lung tissue; or by collapse of the lung. If such retraction be extreme, lateral curvature of the spine will ensue, the convexity of the curve being directed toward the sound side.

Occasionally there is found a considerable depression at the lower end of the sternum; at the bottom of this depression lies the ensiform cartilage. Such a condition is the result of developmental defects, and is known as the "**funnel-breast.**" An analogous condition may be produced by prolonged pressure in certain occupations ("shoemaker's breast").

Surface Anatomy of the Thorax and Relation of Contents of the Surface.—The upper margin of the sternum corresponds to the cartilaginous disc between the second and third dorsal vertebræ. The junction of the manubrium with the

gladiolus is marked by a transverse ridge. The second costal cartilages articulate with the sternum at that point. The depression over the lower end of the sternum or xiphoid cartilage is called *scrobiculus cordis*, or "pit of the stomach." This is opposite the seventh costal cartilages, and corresponds to the ninth dorsal vertebra behind.

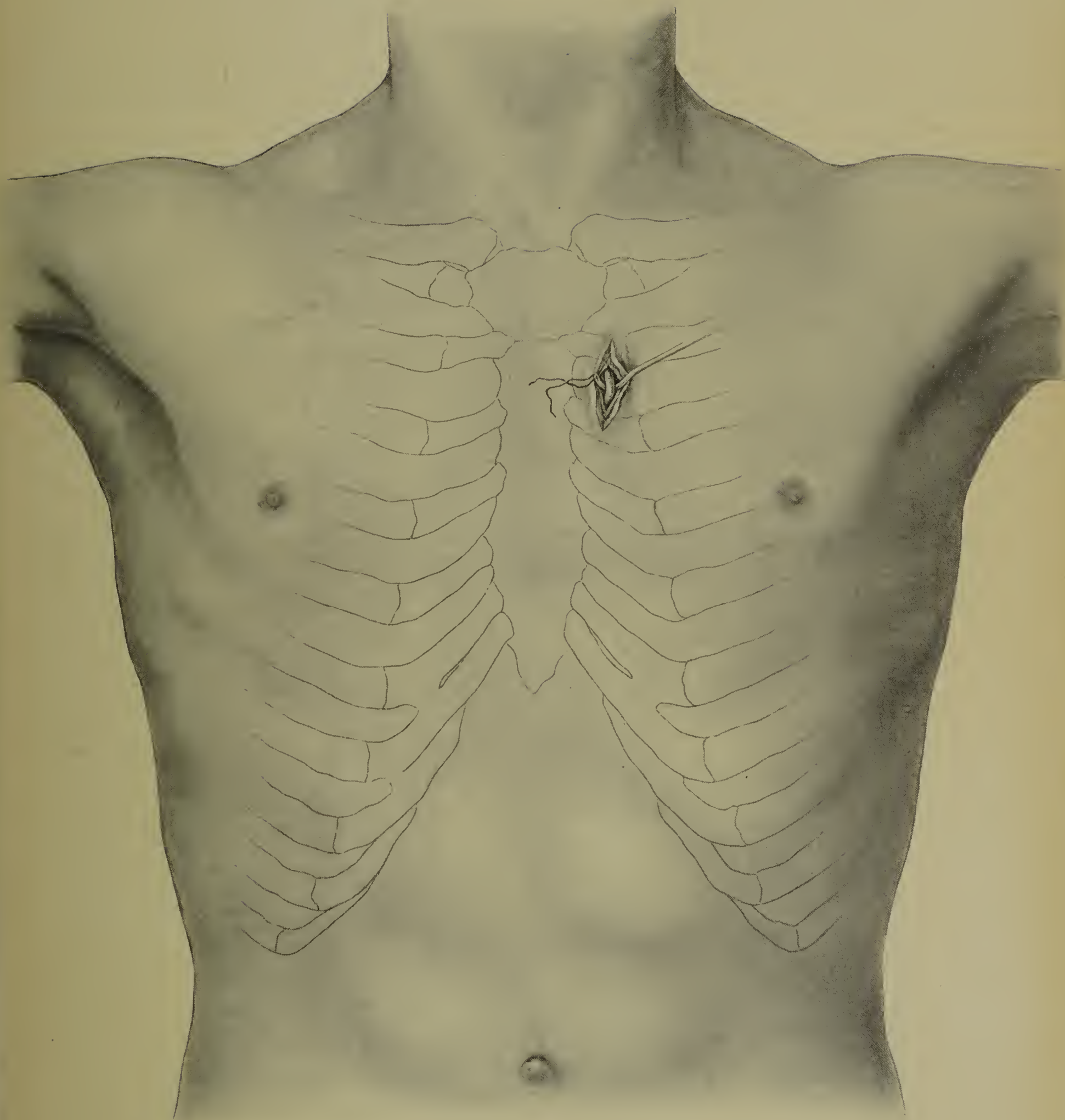
The **sterno-clavicular junction** is prominent. Behind it on the right side lie the innominate artery, the right innominate vein, and the right pleural sac; behind the left sterno-clavicular joint are found the left innominate vein, the left carotid artery, and the left pleural sac. The sterno-clavicular joint is quite mobile and forms the chief means of uniting the upper extremity to the trunk. Dislocation of the clavicle at this point sometimes occurs. It may take place forward, backward, or upward, in this order of frequency.

The **acromio-clavicular joint** is a firm one, owing to the conoid and trapezoid ligaments. Dislocation of the clavicle may take place at this joint; it is usually upward in direction owing to the beveling of the apposed surfaces of bone.

It is frequently necessary to count the ribs. This is readily done in lean persons, but in fat people it is difficult. Still, certain ribs may be located in any individual. The **first rib** lies immediately beneath the clavicle. The **second rib** is identified by the prominent ridge which marks the line of junction of the manubrium with the gladiolus, at which point the costal cartilage of this rib joins the breast-bone. The **fourth interspace** is marked by the nipple in the male; so the fourth rib forms the upper boundary of this interspace. The course of the **fifth rib** is marked by the lower margin of the great pectoral muscle. A line drawn horizontally around the chest over the nipple on the male chest intersects the **sixth interspace** midway between the anterior and posterior median lines. When the arm is raised, the **sixth rib** is marked by the highest visible digitation of the serratus magnus muscle; each succeeding digitation indicates the next lower rib. The position of the scapula between the **second** and **seventh ribs** in the ordinary position of the shoulder is a useful, though variable, index. The **last two ribs** are readily felt, except in very corpulent individuals. The kidneys lie in front of them, the right being located lower than the left owing to the presence of the liver on that side.

From the vertebræ the ribs slope downward and forward. The anterior end of each rib is on a level with the third vertebra below the one with which it articulates. This is a general rule, subject to variations dependent upon changes in the length of the sternum.

The **delto-pectoral groove** lies below the clavicle and between the deltoid and the sternal portion of the pectoralis major muscle. Into it passes the cephalic vein to join the axillary; from it emerges the descending branch of the acromio-thoracic artery; both traverse the delto-pectoral groove. Except in very muscular indi-



LIGATION OF INTERNAL MAMMARY ARTERY.

viduals, the inner side of the coracoid process of the scapula can be felt projecting from under the deltoid into the outer part of this depression when the arm is abducted. It is, therefore, possible to determine whether the process be fractured or not. Through this interval the axillary artery may be compressed against the second rib.

Behind the **manubrium sterni** there is usually no lung tissue. This part of the chest is occupied as follows: The remains of the thymus gland lie immediately behind the manubrium; the left innominate vein crosses behind the latter just below its upper border; the innominate, the left common carotid, and the left subclavian arteries, branches of the transverse portion of the aortic arch, come next; the trachea and its division into the primary bronchi lie behind these, and the esophagus is back of all. The highest part of the aortic arch is about one inch (2.5 centimeters) below the upper margin of the sternum. The remains of the thymus gland lie nearest the sternum, in front of the other structures named.

The **innominate artery** extends from above the middle of the junction of the manubrium and gladiolus to the right sterno-clavicular joint.

The **internal mammary artery** lies behind the costal cartilages parallel to, and a half inch (1.3 centimeters) from, the margin of the sternum. It gives off a perforating branch to each interspace, that to the second being the longest. The internal mammary artery can be ligated in almost any interspace, but the second is preferably selected for that purpose.

In **viewing the thorax from behind**, the surface markings of the back, as described in volume II, under "Surface Anatomy of the Back," are seen. In the floor of the median furrow the spines of the vertebræ can be felt. On each side of the furrow the muscles of the erector spinæ group are located. The spinous process of the seventh cervical vertebra is particularly prominent. As these spines slope downward and backward, their tips are on a lower plane than the bodies of the corresponding vertebræ. Slight frictional strokes will cause red spots to appear over the tips of the spines. The latter can also be made more prominent by bending the body forward. The third dorsal spinous process is opposite the vertebral end of the scapular spine, and corresponds to the highest point attained by the aorta in front of the vertebral column, to the bifurcation of the trachea, and to the apex of the lower lobe of the lungs. Opposite the fourth dorsal spine the aortic arch ends, and there the upper margin of the heart is located; the seventh corresponds to the lower angle of the scapula; opposite the eighth are the lower level of the heart and the central tendon of the diaphragm; opposite the ninth, the vena cava and esophagus pass through the diaphragm, on a level with the top of the spleen; opposite the tenth is the lower edge of the lung, the liver becomes superficial behind, and we have the upper opening of the

stomach; the twelfth indicates the lowest part of the pleura, the aortic opening of the diaphragm, and the pylorus of the stomach.

The **primary bronchi** are indicated by lines extending from the third thoracic spine, or a point a little below it, to the dimple in the skin over the root of the scapular spine. As the right bronchus is nearer to the back of the chest, sounds in it are heard more clearly.

For the purpose of locating and describing pathologic conditions of the thoracic contents, the clinician makes use of certain lines, and also applies to the various regions of the chest-wall certain names:

The **sternal line** is drawn along the outer border of the sternum. The **mid-sternal line** is the median line of the sternum. The **para-sternal line** extends midway between the sternal line and the line of the nipple (**mammillary line**). The **axillary** or **mid-axillary line** is one dropped vertically from the highest portion of the axilla. The **anterior** and **posterior axillary lines** are dropped vertically from the point of junction of the anterior and posterior axillary folds with the chest-wall. The **scapula line** is one drawn vertically, passing through the inferior angle of the scapula. The names applied to the various regions of the chest are self-explanatory; thus, we speak of the **infra-clavicular fossa**, the **sternal**, **mammary**, and **infra-mammary regions**, the **lateral thoracic region**, the **supra-spinous** or **supra-scapular region**, the **infra-scapular region**, etc.

The **position of the heart** can be indicated by lines drawn on the surface. From a point (A) on the right third costal cartilage, half an inch (1.3 centimeters) from the border of the sternum, draw a line to a point (B) in the second interspace on the left side, one inch (2.5 centimeters) from the sternal margin, to locate the base. From a point (C) in the fifth interspace, one inch (2.5 centimeters) to the inner side of and two inches (5.1 centimeters) below the left nipple, draw another line along the lower end of the gladiolus to a point (D), half an inch (1.3 centimeters) beyond the right border of the sternum, in the fifth interspace, to define the margin of the right ventricle as it rests upon the central tendon of the diaphragm. Connect the point (A) with (D) to indicate the right border of the heart. Join B and C to find the left margin of the heart. The corners of this space should be rounded; that near the nipple should be the sharpest, and the right lower angle the least so. The left upper angle marks, approximately, the position of the left appendix auriculæ. A needle passed through the second right interspace would strike the sinus of the aorta; through the first right interspace the needle would enter the superior vena cava; in both instances the instrument would first traverse the anterior fringe of the lung. The points for aspiration of the pericardium are found in the fourth interspace at the left border of the sternum;

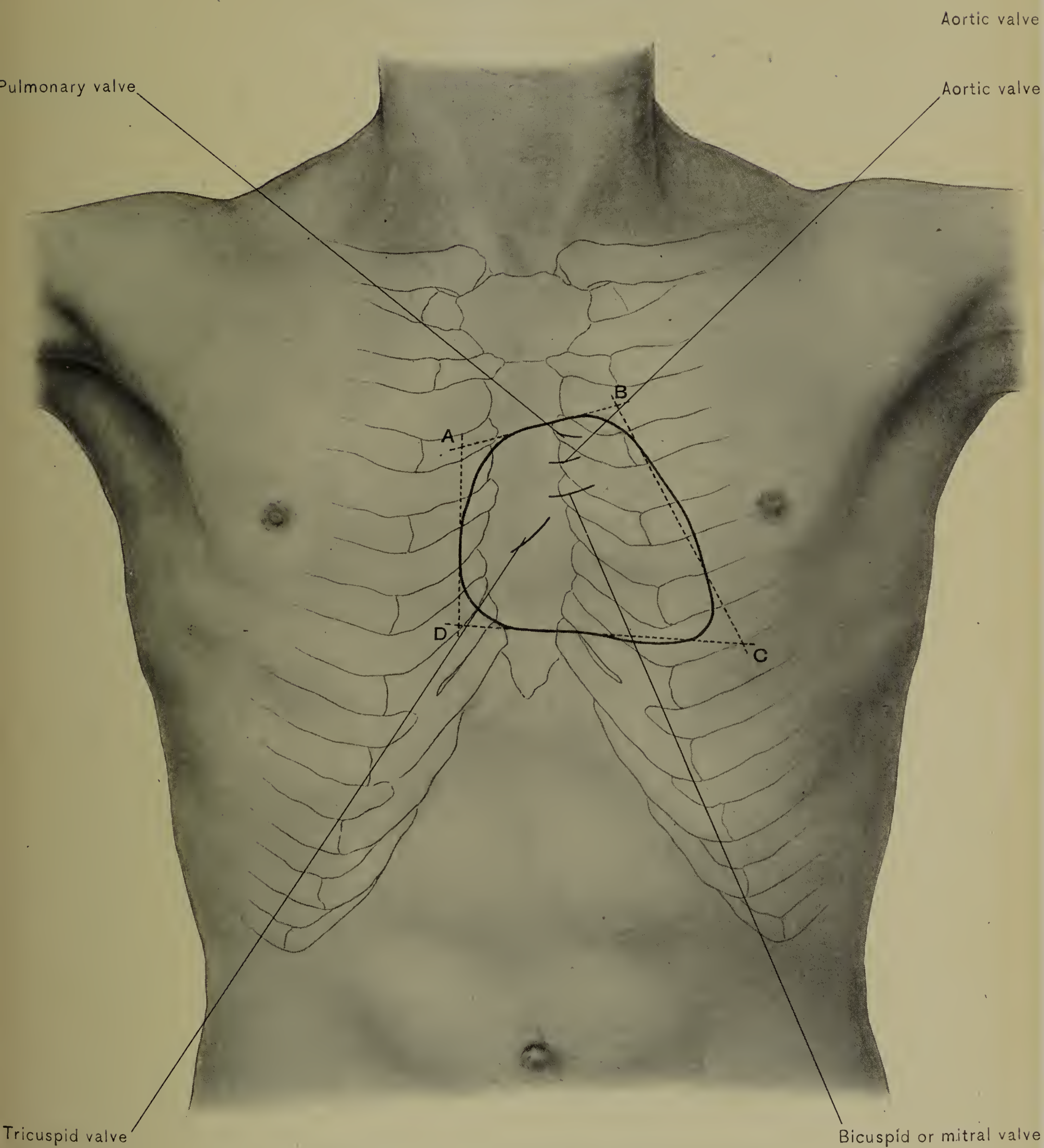
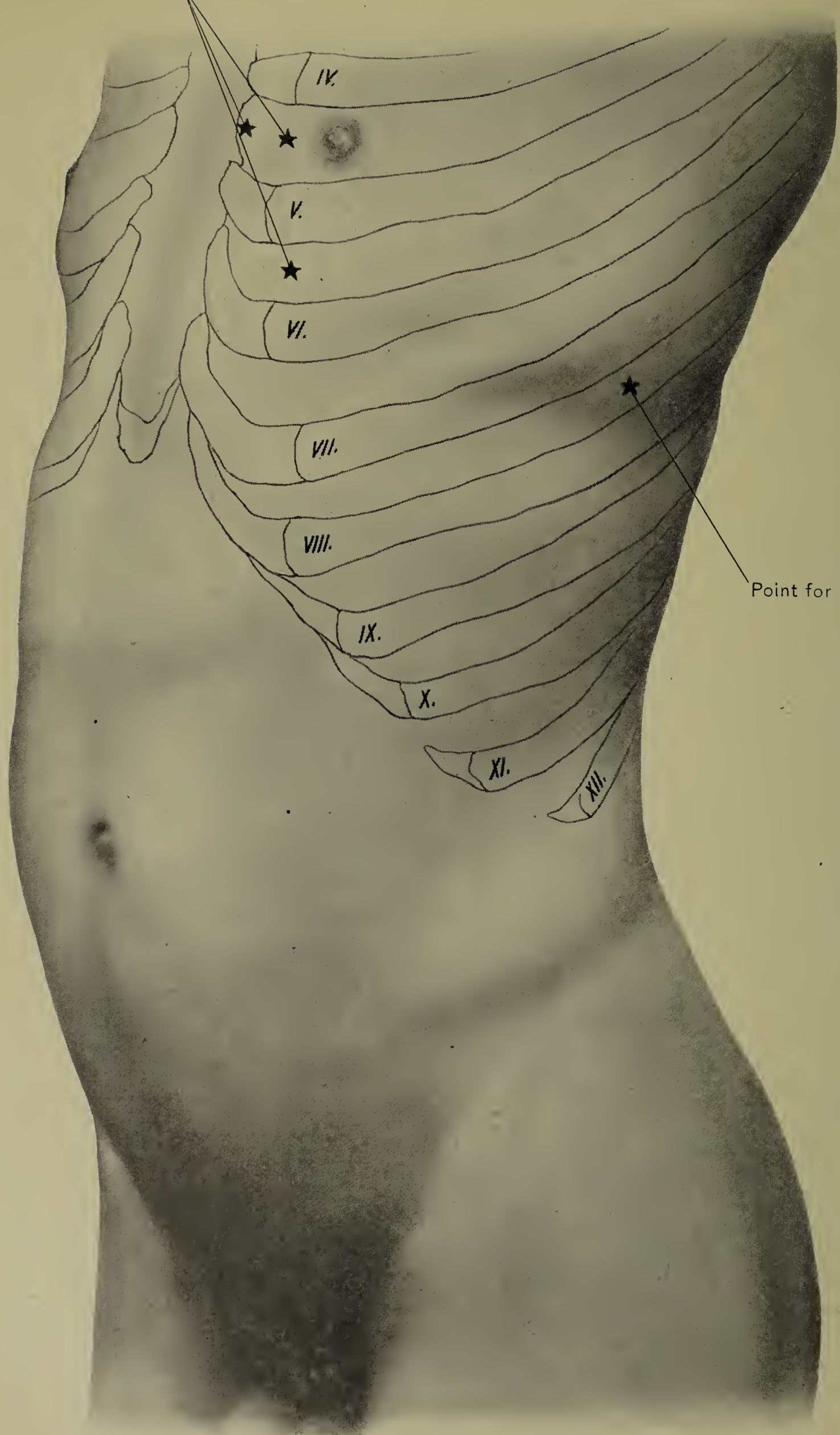


DIAGRAM OF POSITION OF HEART AND LOCATION OF CARDIAC VALVES.

Points for aspirating pericardium



Point for aspirating pleura

in the fourth interspace, one inch (2.5 centimeters) from the left sternal margin ; or in the fifth interspace, one and a half inches (3.8 centimeters) from the left sternal border. A very large effusion can be advantageously reached in the left xipho-costal angle.

The **region of precordial dulness** is thus well outlined in Dr. Latham's "Clinical Lectures": "Make a circle of two inches in diameter round a point midway between the nipple and the end of the sternum. This circle will define, sufficiently for all practical purposes, that part of the heart which lies immediately behind the wall of the chest, and is not covered by lung and pleura."

The **apex-beat of the heart** is usually in the left fifth interspace, one and one-half inches (3.8 centimeters) below, and three-fourths of an inch (1.9 centimeters) to the inner side of, the nipple. But this varies with changes in the position of the body and during deep respiration ; it descends in inspiration. Its changes, due to altered positions, are readily studied upon himself by any individual, as it is very distinct while lying upon the left side. The pulsation is slightly noticeable when the body reclines upon the right side, and is more perceptible when the person rests upon the back.

Location of the cardiac valves.—The *aortic valves* are found behind the sternal end of the third left intercostal space ; the *pulmonary valves* are a little above, behind the third left chondro-sternal junction ; the *tricuspid* valve is placed behind the middle of the sternum at the level of the fourth intercostal space ; and the *mitral valve* is situated behind the fourth left costal cartilage at the left border of the sternum. Being covered by the anterior margin of the lung, their sound can be more distinctly heard if breathing is suspended.

The **lungs** extend from one inch and a half (3.8 centimeters) to two inches (5.1 centimeters) above the first rib, and are covered by the pleura and by a portion of the cervical fascia. The subclavian arteries arch over the apex of the lungs on either side. They are higher in women than in men. Behind the middle piece of the sternum, between the levels of the second and fourth cartilages, they approach the median line by a thin border. The lungs gradually diverge below the fourth cartilage to follow the chondral margin. The anterior margin of the left lung is notched to accommodate the heart. The margin of the right lung descends in almost a straight line to the sixth chondro-sternal junction. The lungs extend downward as far as the sixth rib, in the nipple line ; as low as the eighth rib in the axillary line ; and down to the tenth rib behind in the line of the inferior angle of the scapula (the arms being held close to the sides). The lower pulmonary margins descend about an inch and a half in deep inspiration.

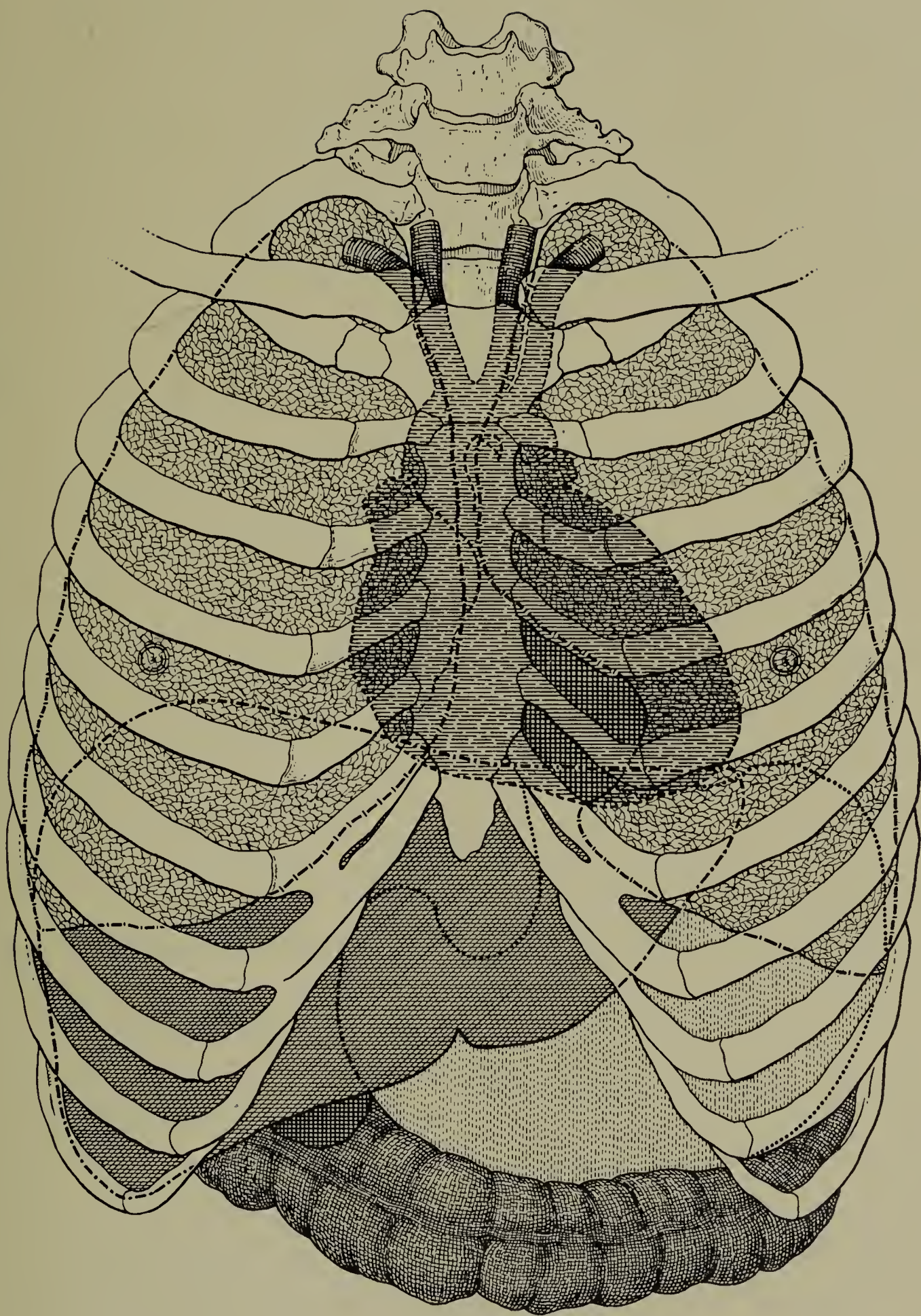
The *fissures* dividing the lungs into lobes can be marked as follows: The great fissures can be outlined by drawing lines from the second dorsal spinous

process, which corresponds to three inches (7.5 centimeters) below the apex of the lung, downward and forward to the junction of the sixth rib with its cartilage. On the right side a second fissure extends from the middle of the preceding line to the fourth chondro-sternal junction. Thus it will be seen that the left lung is divided into two, the right into three lobes. The lower lobes form almost the entire posterior surface of the lungs, and the upper lobes almost the entire anterior surface.

The **pleural sac** can be aspirated for the purpose of withdrawing fluid in the seventh interspace in the mid-axillary line, or in the ninth interspace to the outer side of the lower angle of the scapula.

Behind the manubrium sterni the pleural sacs are separated by an angular interval, but behind the upper portion of the gladiolus they are contiguous. The left may even overlap the right pleural sac at this point. At the level of the fourth chondro-sternal junction the pleuræ diverge, the right being continued downward to the seventh costal cartilage in almost a straight line; the left deviates outward.

The line of the left pleura is traced from the fourth chondro-sternal junction, at first outward and downward across the fourth interspace at a variable distance from the mid-sternal line, leaving a small triangular portion of the pericardium thus exposed. It is then continued downward across the fifth cartilage, fifth interspace, and sixth cartilage, usually close to the margin of the sternum, from where it inclines obliquely downward and outward to reach the seventh costal cartilage. From there it passes across and along the seventh and eighth, ninth and tenth ribs, which latter rib it reaches midway between the spinal column and the sternum. The lower border of the left pleura is slightly below the plane of the right, extending to the lower border of the tenth rib in the mid-axillary line. From this point the lower limit of the left pleura corresponds to that of the right. The pleura extends much lower down than the lung. Its lower margin on the right side reaches the seventh costal cartilage near the sternum and extends from there outward and downward and backward along the seventh costal cartilage; it reaches the ninth interspace in the mid-axillary line. It crosses the tenth rib and is continued along the eleventh rib to the neck of the twelfth rib. Holden calls attention to the liability of a foreign body, like a musket-ball, after it has entered the pleural sac, to fall or roll to its most dependent part, which corresponds to the vertebral extremity of the last rib, where it may be found and extracted. He also mentions the last interspace, at the outer edge of the erector spinæ muscle, as favorable for drainage of the pleura, but cautions against the use of a trochar, as it might enter the abdomen through the diaphragm, and advises that a knife be used instead, care being taken to cut below the middle of the space so as to avoid the intercostal artery.



POSITION OF THE HEART AND LUNGS.

THE THORACIC WALL.

DISSECTION.—In the dissection of the upper extremity the skin and fasciæ, as well as the pectoral muscles, will have been removed. Along the sternum and costal cartilage will be noticed the remains of the pectoralis major muscle; laterally, the attachments of the pectoralis minor, serratus magnus, external oblique, and latissimus dorsi muscles; and below, the rectus abdominis muscle. Above will be seen the subclavius and the scaleni muscles. Posteriorly are the muscles of the back. These should be removed, with the exception of the scaleni muscles, and the intercostal spaces and the ribs exposed. The lateral cutaneous branches of the intercostal nerves should be noted emerging between the serrations of the serratus magnus muscle, also the anterior cutaneous branches of the intercostal nerves and the perforating branches of the internal mammary artery as they pierce the origin of the pectoralis major muscle close to the sternal margin.

The **thoracic wall** is composed of bone, cartilage, muscle, membrane or fascia, nerves, vessels, and lymphatics. The thickness of the thoracic wall may vary in different individuals; this should therefore be considered in physical examination of the chest. During respiration a decided movement of the chest-wall takes place, permitted by the rotation of the ribs, producing considerable alteration in the capacity of the thorax. The walls of the thorax, owing to the elasticity of the ribs and costal cartilages, are markedly yielding, especially in young subjects. This in a great measure prevents fractures and dislocations of the sternum and ribs.

The **sternum** is composed of three parts: viz., manubrium, gladiolus, and the ensiform or xiphoid cartilage. A transverse ridge marks the junction of the manubrium and gladiolus, and this is the most frequent seat of dislocation and fracture. The xiphoid is usually perforated, but may be bifid. The xiphoid branches of the internal mammary arteries pass through the opening. The upper border of the manubrium presents the suprasternal or interclavicular notch, and becomes continuous on each side with the notch for the articulation of the sternal end of the clavicle. Laterally the sternum shows depressions or notches for articulation with the upper seven, or rarely eight, costal cartilages. The costal cartilage of the first rib is continuous with the manubrium, and therefore an exception to this. The sternum gives attachment to the following muscles: the pectoralis major, sterno-mastoid, sterno-hyoid, sterno-thyroid, rectus abdominis, internal intercostals, triangularis sterni, diaphragm, and transversalis abdominis. These muscles by pulling against each other, as in bending the spine backward, may cause a fracture of the sternum. Fracture, however, rarely occurs, owing to the cancellous structure of the bone and the elasticity of the ribs and costal cartilages.

which support it. In old age, when the cartilages have become ossified, the chest-wall no longer yields and the sternum is more liable to fracture. The sternum may be fractured by direct violence, but is most apt to be broken in injuries to the spinal column. Extreme forward and backward bending of the spine will likewise cause fracture. The line of fracture is almost always transverse, and usually at the junction of the manubrium and gladiolus. Dislocations sometimes occur at the junction named in young subjects in whom these parts have not as yet united. The manubrium in such cases, as a rule, is kept in place by the clavicles and first ribs, and the gladiolus glides in front of it.

Aneurysms of the ascending portion of the arch of the aorta, by constant pressure will cause bulging of the thoracic wall and finally necrosis and absorption of the sternum or adjacent costal cartilages, and may then rupture externally through the skin overlying the part. Necrosis from other causes, such as gummatous change, is often observed. The bone, owing to its sponginess, has been penetrated by knife thrusts. It may be trephined and abscesses and pericardial effusions drained in that manner.

Congenital defects, such as clefts or openings, are sometimes observed in the sternum. These are usually so small as to be barely recognizable, but occasionally are of good size, allowing a view of the pulsating heart. Rarely the sternum may be entirely cleft; or the two sides, united only at the manubrium, are separated below that point. Mediastinal abscesses may discharge or surface abscesses burrow through these clefts or openings. The sternum may undergo change in shape and position in persons whose occupation requires instruments to be pressed against the chest.

The **ribs** are flat, narrow, very much curved, elastic bones, united behind to the dorsal vertebræ by ligaments and articulating in front with the costal cartilages. They slope obliquely downward from behind forward, so that the tips are much below the heads of the corresponding ribs, a general rule being that the tip of a rib is on a level with the head of the fourth rib below it. The most oblique rib is the ninth. The upper seven or eight ribs, by means of their respective costal cartilages, are united to the sternum and are called "true ribs." The eighth, ninth, and tenth join the cartilage of the seventh rib; and the last two, called "floating ribs," are free at the tip, and may be readily palpated even in fat subjects.

The lower border of the ribs is grooved for the intercostal vessels and nerves, the vein being above the artery and the nerve below it. In hemorrhage from an intercostal artery it may be necessary to pass the ligature around the rib to compress the vessel.

Owing to the elasticity of the ribs and costal cartilages, these structures yield to pressure and are not readily broken. In the old, in whom the cartilages have

become ossified, fractures of the ribs are more frequent. The ribs most frequently fractured are the sixth, seventh, and eighth. The first rib is least liable to be broken, owing to its protected position.

Fractures of the ribs may be produced by direct violence, the fracture occurring at the point struck; this would tend to drive the fragments inward and injure the pleura. Or they may be produced by indirect violence, force being applied at a point remote from the seat of fracture, as in a crush of the chest by heavy weights, causing such an increase in the curve of the ribs as to cause them to break. In such cases the direction of the fracture is outward and away from the pleura. Displacements of the fragments and shortening of the ribs are rendered quite impossible by the intercostal muscles that are attached to the ribs, unless several adjacent ribs be broken. Rarely diseased or weak ribs may be fractured during violent fits of coughing or during labor.

The ribs frequently deflect a bullet from its course, the latter then following the curve of the rib around the thorax under the skin.

In some affections of the pleural cavity, as empyema, the resection of one or more ribs is necessary. Such a procedure, devised by Estlander, is called **thoracoplasty**.

The bodies of the dorsal vertebræ and the intervertebral discs, bound together by ligaments, form the thoracic wall behind. Caries of the vertebræ, as in Pott's disease, causes deformity of the spine, as well as of the sternum and ribs, and produces shortening of the body, often to such an extent that the lower ribs extend below the iliac crests.

The **intercostal spaces**, the intervals between the ribs and costal cartilages, differ in width; they are wider anteriorly than posteriorly and the upper spaces are wider than the lower. The third, second, and first are the widest, in this order; while the lowest four are the narrowest. These spaces are closed by the external and internal intercostal muscles, between which run the intercostal vessels and nerves. The action of these muscles during inspiration narrows the spaces by elevating and rotating the ribs.

The eleven interspaces between the ribs are filled with the external and internal intercostal muscles and the intercostal fasciæ or membranes. Between the two strata of muscles lie the intercostal vessels, nerves, and lymphatics.

The **external intercostal muscles** extend obliquely between adjacent ribs, their tendino-musculo fibers passing downward and forward, like those of the abdominal external oblique muscle, of which they are virtually continuations, intersected by osseous interruptions (the ribs). They arise, in each interspace, from the lower or outer border of the upper rib (except the last), to insert into the upper border of the rib below (with the exception of the first), and extend forward from

the tubercle of the ribs to the ends of the ribs, beyond which point they are continued to the sternum as fibro-tendinous membranes, the **anterior intercostal membranes**, or **external intercostal fasciæ** (more properly called **interchondral membranes**), except in the last two interspaces, the muscles there extending to the tip of the last two ribs. The attachments of these muscles at the back of the chest are more readily seen from the inside of that cavity after its contents have been removed.

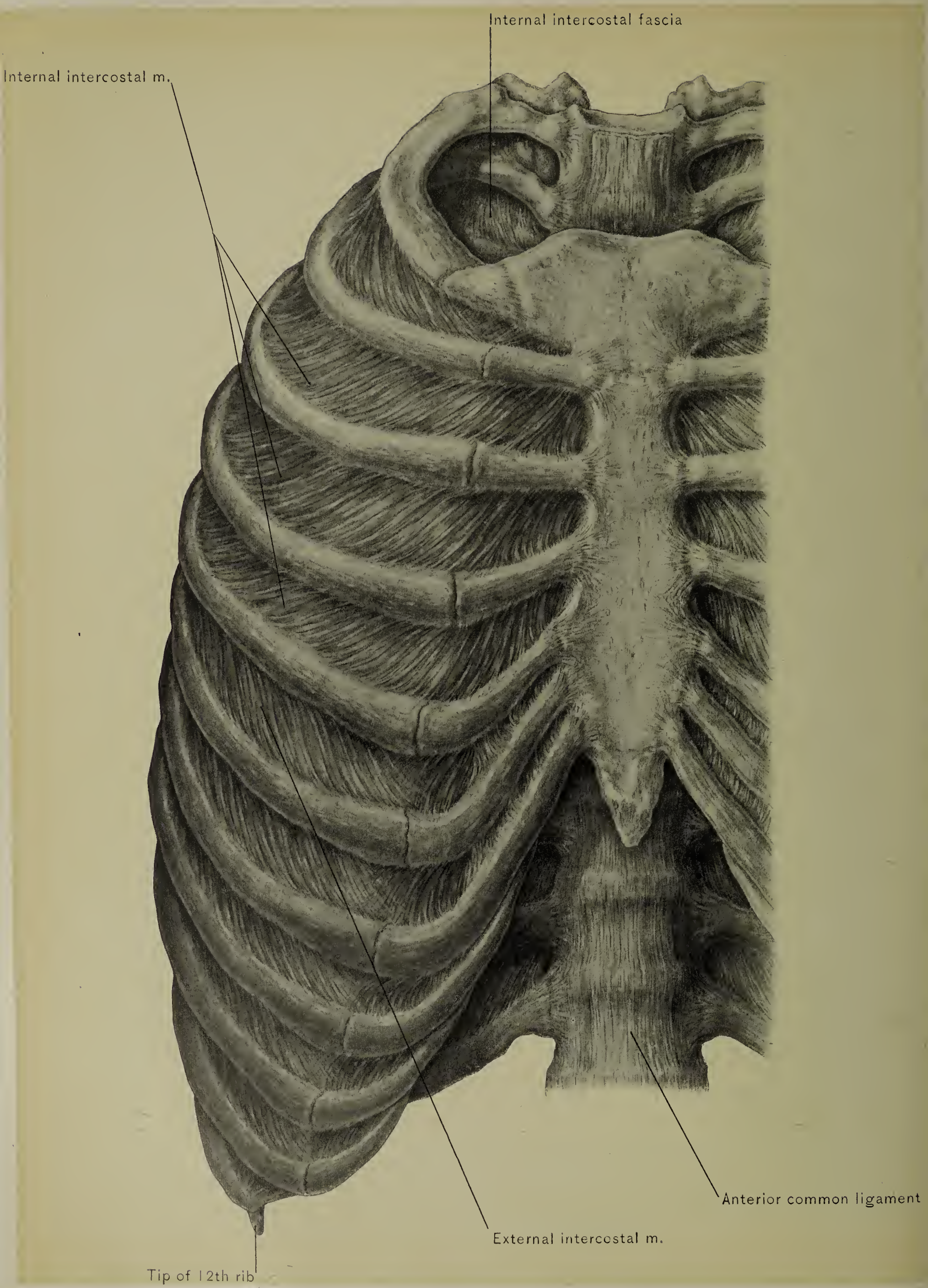
RELATIONS.—The external intercostal muscles are covered by the pectorales major and minor, the serratus magnus, the external oblique, the latissimus dorsi, the levatores costarum, the upward continuation of the erector spinæ, the serratus posticus superior and inferior, the rhomboideus major and minor, and the trapezius muscles. By their deep surface they are in relation with the middle intercostal fascia which separates them from the internal intercostal and the infracostal muscles, and the intercostal vessels and nerves.

DISSECTION.—The external intercostal muscles and the external intercostal membranes should be severed along their attachment to the lower rib in the interspace in which they lie. They should then be reflected upward, care being taken not to injure the intercostal vessels and nerves that lie between the external and the internal intercostal muscles, covered by the middle intercostal fascia, which intervenes between the two strata of muscles. This should now be removed and the vessels and nerves exposed.

The **internal intercostal muscles** differ from the external in that their fibers run downward and backward. They extend from the edge of the sternum as far back as the costal angles, beyond which, to the costal tubercles, they are continued as the **posterior intercostal membrane**, also called **internal intercostal fascia**. They arise from the inner surface of the upper rib, above the inner margin of the subcostal groove, to be inserted into the inner surface of the lower rib near its upper margin. In the last two interspaces these muscles are continuous with those of the abdominal internal oblique muscle.

RELATIONS.—The internal intercostal muscles are covered by the middle intercostal fascia (the intercostal vessels and nerves intervening) which separates them from the external intercostal muscles; the anterior intercostal membranes, also called external intercostal fascia, cover them between the cartilages. Deeply they are in relation with the pleura, the triangularis sterni, and the infracostal muscles.

From the foregoing description it will be seen that the direction of the fibers of the external and internal intercostal muscles is such as to cross at an acute angle, like the bars in the letter **X**. Displacement of the fragments in fractures of the ribs is rendered almost impossible by this arrangement.



THE INTERCOSTAL MUSCLES.

NERVE SUPPLY.—The intercostal muscles are supplied by filaments of the intercostal nerves.

The **levator costarum muscles** have been described with the muscles of the back. They arise from the tips of the transverse processes of the last cervical and the upper eleven dorsal vertebræ, to be inserted into the upper border of the next rib below each transverse process, from the tubercle to the angle. The levatores costarum also are inserted into the second rib below their origin.

RELATIONS.—They are covered by the upward continuation of the erector spinæ muscles, and ventrally are in relation with the external intercostal muscles, with which they are continuous by their outer borders.

The **infracostal muscles**, or **subcostals**, cover the internal surface of the ribs from the tubercle to the angle. They vary in length and development, being usually stronger below. They arise from the inner surface of one rib to be attached to the inner surface of the first, second, or third rib above, the direction of their fibers being oblique like the internal intercostal muscles. They can best be seen from within the thorax, after the removal of its contents.

RELATIONS.—These muscles lie in front of the vertebral extremities of the ribs and the external and internal intercostal muscles in that region. Their thoracic or internal surface is covered by the parietal pleura, from which they are separated by a thin fascia called the **endothoracic fascia**.

DISSECTION.—The sternum should be sawed through opposite the first and sixth interspaces, the costal cartilages cut through near the sternum, and pieces of several cartilages excised to show the internal mammary artery; the severed sternum and cartilages should then be removed by cutting away the attachment of the triangularis sterni muscle. Great care must be taken not to injure the pleura or the internal mammary arteries. This piece of the sternum should be preserved so that it may be replaced when studying the relations of the thoracic viscera to the surface.

The **triangularis sterni**, or **transverse thoracic muscle**, is virtually an upward extension of the transversalis abdominis; it arises from the back of the lower part of the sternum and the ensiform cartilage and the adjacent ends of the fifth, sixth, and seventh costal cartilages, and is inserted by five digitations into the back part of the costal ends of the second, third, fourth, fifth, and sixth cartilages, sometimes encroaching upon the ribs. It varies considerably in size. The lower fibers are horizontal and are continuous with the transversalis abdominis muscle.

NERVE SUPPLY.—All the muscles of this group are supplied by the intercostal nerves.

ACTION.—The intercostal muscles are the chief factors in moving the ribs. After the first rib has been fixed by the scaleni muscles, they elevate and rotate the

ribs and thus increase the capacity of the thorax and therefore aid the diaphragm in inspiration. They are aided by the levatores costarum muscles. The triangularis sterni and the infracostals depress the ribs and costal cartilages, and are muscles of expiration. In forced inspiration, after fixation of the shoulder and scapula, the trapezius, the pectoralis minor, the serratus posticus inferior and superior, the rhomboid, and possibly the lower fibers of the serratus magnus, assist. By fixing the head, the sternomastoid aids forced inspiration, drawing up the sternum and fixing the clavicle, thus giving the intercostal muscles a fixed point from which to act.

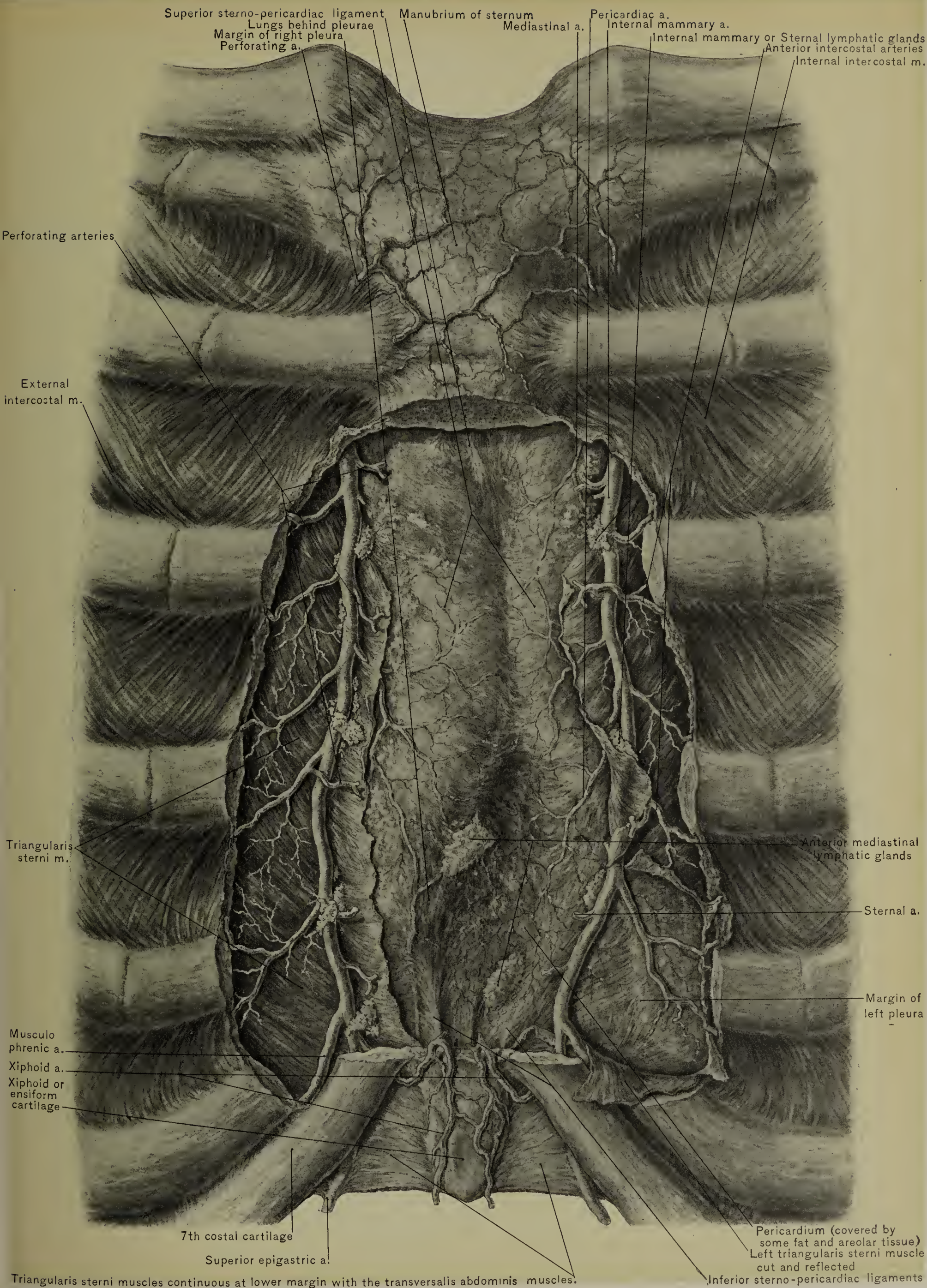
Ordinary expiration probably is not dependent on muscular effort, but is the result of the elastic lungs and chest-wall returning to a condition of rest. In forced expiration the muscles of the abdomen, the triangularis sterni, and the infracostals are brought into play. The quadratus lumborum and ilio-costalis muscles, by fixing the last rib, likewise increase the expiratory effort and allow the lower intercostal muscles to aid in expiration.

The **internal mammary artery** arises from the first part of the subclavian artery, opposite the origin of the thyroid axis, passes downward behind the clavicle, and enters the thorax, lying between the cartilage of the first rib and the parietal layer of the pleura. The artery descends in almost a straight line vertically downward, crossing the interspaces on the internal surface of the thoracic wall, about one-half inch (1.25 centimeters) from the sternal margin. It should be avoided in the tapping of pericardial effusions, the points for which were mentioned under Surface Anatomy of the Thorax. At the sixth interspace the artery divides into its terminal branches—the **superior epigastric** and the **musculo-phrenic arteries**.

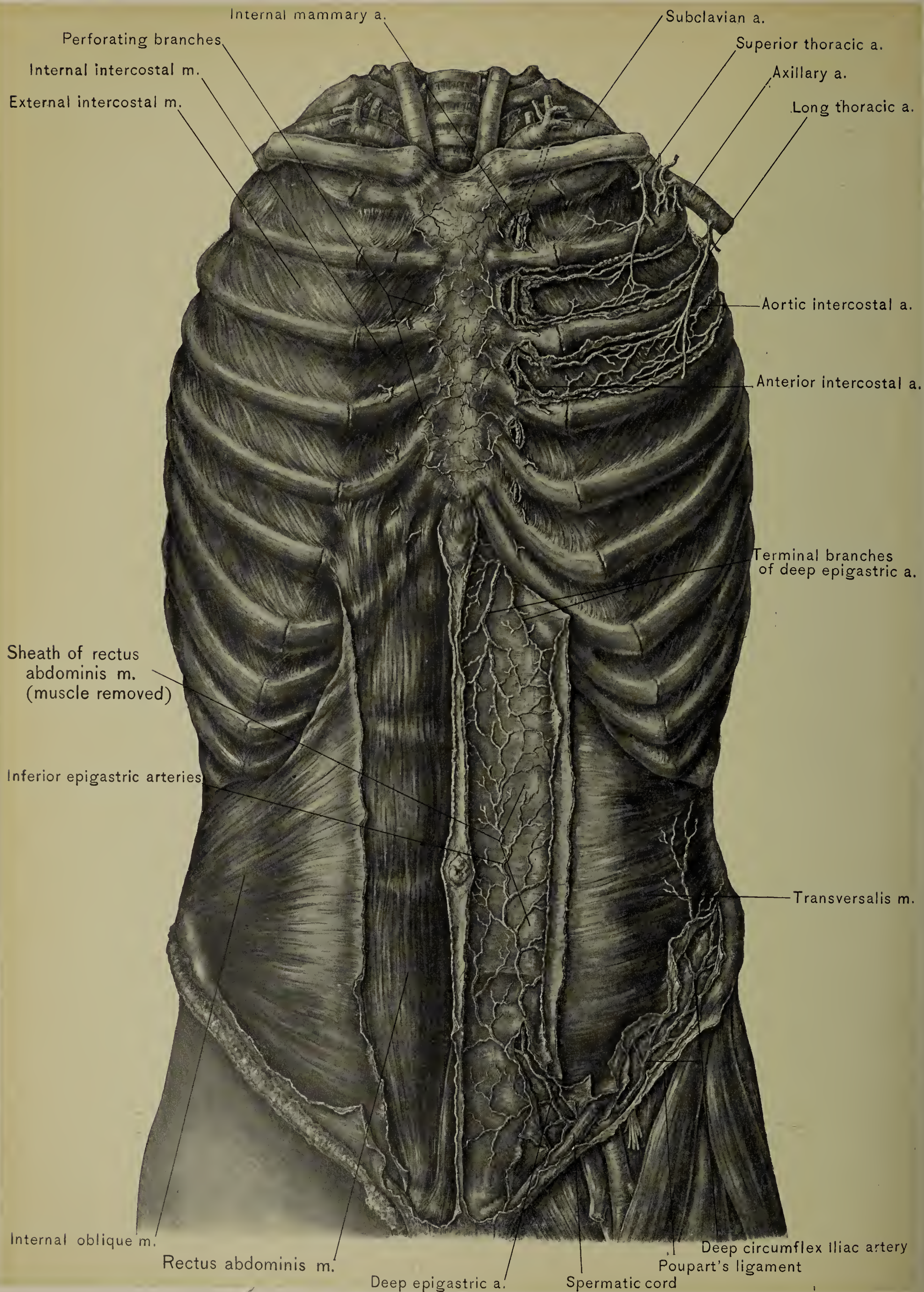
The internal mammary artery may be described as consisting of two portions—a cervical and a thoracic.

The *cervical portion* is short and extends from the origin of the artery to the upper border of the first costal cartilage. No branches are given off from it. It is covered in front by the subclavian and internal jugular veins; behind, it lies on the pleura. The phrenic nerve crosses it obliquely from without inward.

The *thoracic portion* begins at the upper border of the first costal cartilage and ends at the division of the artery into its terminal branches at the sixth costal cartilage. In front of it are the upper six costal cartilages, the internal intercostal muscles, the external intercostal membrane, and the sternal fibers of the pectoralis major muscle. Behind it are, above, the pleura; lower down, the triangularis sterni muscle. On the left side, between the fourth and sixth costal cartilages, it can be regarded as being contained in the anterior mediastinum, as the pleura here deviates to the left to form a notch. The artery can be quite easily tied in



ANTERIOR MEDIASTINUM.



EPIGASTRIC AND DEEP CIRCUMFLEX ILIAC ARTERIES.

the upper three interspaces, the second interspace being the one preferred. Lower down, the interspaces become too narrow and resection of the costal cartilages is there necessary to expose the artery.

The branches of the internal mammary artery are: The superior phrenic; the mediastinal, or thymic; the pericardiac; the sternal; the anterior intercostals; the perforating; the lateral infracostal; the superior epigastric; and the musculo-phrenic.

The *superior phrenic artery*, or *comes nervi phrenici*, is given off behind the first costal cartilage, and accompanies the phrenic nerve to the diaphragm; it comes in relation with the pleura to the outer side, and with the innominate vein, the superior vena cava, and the pericardium to the inner side, in its course to the diaphragm. It gives off branches to both pleura and pericardium, and anastomoses with the other phrenic arteries in the diaphragm.

The *mediastinal* or *thymic branches* are small, and supply the fat and areolar tissues and lymphatics in the superior and anterior mediastinal spaces, and the remains of the thymus gland.

The *sternal branches* enter the nutrient foramina of the sternum and supply the triangularis sterni muscle.

The *anterior intercostal arteries* arise quite irregularly from the internal mammary artery in the upper five or six interspaces, and from the musculo-phrenic, one of the terminal branches of the internal mammary artery, below that point. In each of the interspaces, one artery passes along the upper border of the rib below and another along the lower border of the rib above; these arise separately from the internal mammary or the musculo-phrenic artery, or sometimes by a common trunk, which then divides into the branches described. These branches follow the course of the ribs and anastomose in the first interspace with the branches of the superior intercostal artery, and in the other interspaces with the aortic intercostal arteries. At first these arteries lie between the internal intercostal muscles and the pleura; later, between the external and internal intercostal muscles, which they supply, together with the ribs.

The *perforating branches* arise from the front of the internal mammary artery and pierce the internal intercostal and pectoralis major muscles to supply the latter and the skin and fascia over that region. They are usually five or six in number, one for each of the upper interspaces. The second, third, and fourth perforating arteries—the second being perhaps the largest—supply the mammary gland and become much enlarged during lactation. They require ligation in the operation of excision of the breast.

The *lateral infracostal artery* arises near the first rib and descends behind the

ribs just outside their junction with the costal cartilages. It is small in size and not constant. It anastomoses with the upper intercostal arteries.

The *superior epigastric artery*, one of the terminal branches of the internal mammary artery, is the direct continuation of that vessel. It leaves the thorax by passing downward behind the seventh costal cartilage and through the space between the costal and sternal attachments of the diaphragm. It then enters the sheath of the rectus abdominis muscle, lying posterior to that muscle at first; later entering it to supply it, and to anastomose with branches of the deep epigastric artery, a branch of the external iliac artery, thereby forming the longest anastomosis in the body. It gives off some small branches to the diaphragm; a xiphoid branch, which anastomoses with its fellow of the opposite side; a few cutaneous branches; muscular branches to the rectus abdominis muscle; several small hepatic branches (on the right side only) that reach the liver by running along the falciform ligament and anastomose with the hepatic artery; and some peritoneal branches, which pierce the posterior wall of the sheath of the rectus abdominis muscle and supply the peritoneum.

The *musculo-phrenic artery* is the other terminal branch of the internal mammary artery and runs outward and downward from the seventh costal cartilage, behind the cartilages of the false ribs, pierces the diaphragm at about the eighth or ninth rib, and continues to the last interspace, where it ends. In its course it gives off anterior intercostal branches as it crosses each interspace, which anastomose, as in the upper interspaces, with the aortic intercostal arteries. Branches are also given off to supply the pericardium, the diaphragm, and the abdominal muscles.

The **internal mammary veins**, two in number, accompany the internal mammary artery to the first interspace, where they unite to form a single trunk, which empties into the corresponding innominate vein at the inner side of the artery; on the right side the vein occasionally empties into the superior vena cava.

The **intercostal arteries** are derived from the internal mammary and the musculo-phrenic arteries anteriorly and from the superior intercostal arteries and the aorta posteriorly. The anterior intercostal arteries usually arise in pairs, two arteries to each interspace, while there is only a single posterior intercostal artery given off to each interspace; this single artery, however, gives off a branch (the collateral intercostal branch) opposite the angle of the rib which crosses the interspace to run along the upper border of the lower rib. The main trunk of the artery continues along the lower border of the upper rib in the subcostal groove. These arteries, like the anterior intercostals, run between the external and internal intercostal muscles and anastomose with those vessels, covered by the middle intercostal fascia.

In all of the interspaces the intercostal nerves lie below, while the veins run

above the arteries, except in the third and fourth spaces, where the nerves at first lie higher than the arteries because the latter run upward to gain the interspaces.

The **anterior intercostal arteries** have been described with the internal mammary artery.

The **superior intercostal artery** is given off from the second portion of the subclavian artery behind the scalenus anticus muscle, but it may be given off from the first portion on the left side at the internal border of that muscle. Its branches are the deep cervical and the intercostal arteries and the *arteria aberrans*. The deep cervical (*profunda cervicis*) artery has been described with the neck.

The *intercostal branch* is really the terminal branch of this artery. It is given off at the neck of the first rib and runs along its lower border to the angle, divides into two branches there, and is distributed like an aortic intercostal artery. Frequently, especially on the right side, after giving off a branch to the first interspace it descends over the neck of the second rib to the second interspace to be distributed in like manner.

The *arteria aberrans*, often absent, usually very small, descends into the thorax from the right superior intercostal artery, or rarely from the subclavian artery, to anastomose behind the esophagus in front of the third thoracic vertebra with a branch of the thoracic aorta that arises below the ductus arteriosus. This anastomosis, when present, is the remains of the right aortic stem, and sometimes is very large, so that the right subclavian artery is then derived from the arch of the aorta and passes behind the esophagus.

The **aortic intercostal arteries** arise in pairs from the posterior aspect of the descending thoracic aorta in the posterior mediastinum, and are generally ten in number. They supply the lower nine intercostal spaces, the upper two being usually supplied by the superior intercostal artery. The tenth or last artery, also called the subcostal artery, owing to its position, runs along the lower border of the last rib and in front of the quadratus lumborum muscle to the tip of the rib, and is then distributed to the abdominal muscles, like the lumbar arteries, with which and the external circumflex iliac artery it anastomoses. Each intercostal artery can be described as consisting of two portions—the vertebral or mediastinal, and the intercostal.

The *vertebral* or *mediastinal portion* lies on the vertebræ. Owing to the position of the aorta to the left of the median line, the vessels are longer on the right than on the left side. The upper aortic intercostal arteries in the adult run upward to reach the interspaces, because of the disproportional rate of growth of the aorta and spinal column. This portion of the arteries comes in relation with the structures of the posterior mediastinum. The arteries of the right side are crossed by the thoracic duct, the vena azygos major, and the esophagus, and are covered by

the pleura. The arteries of the left side are crossed by the vena azygos minor and the intercostal veins, and are likewise covered by the pleura.

The *intercostal portion* of these vessels is found in the interspaces. At first each artery runs across the interspace on the external intercostal muscles and is covered by the endo-thoracic fascia, infracostal muscles, and pleura, to reach the angle of the rib above, at which point it passes in front of the internal intercostal muscles. The collateral intercostal branch, that runs along the upper border of the rib below to anastomose with one of the anterior intercostal arteries, is given off there. The continuation of the artery runs along in the subcostal groove between the external and internal intercostal muscles, to anastomose with the other of the two anterior intercostal arteries given off to each interspace. The sympathetic nerve crosses these arteries opposite the heads of the ribs. The first aortic intercostal artery anastomoses with the superior intercostal artery and sometimes supplies the entire second interspace. This is usually the case on the left side.

In thoracentesis the puncture should not be made further back than the angle of the ribs, as beyond that point the artery runs in the middle of the interspace. A vein and a nerve accompany each artery, the vein being above, the nerve below it, except in the upper interspaces, where the nerve at first lies above the vessels.

The aortic intercostal arteries give off the following branches: The *dorsal branch*, that supplies the muscles of the back and the contents of the spinal canal; the *collateral intercostal branch*, which has been described; *pleural branches*; *muscular branches*; *lateral cutaneous branches*, which accompany the lateral cutaneous nerves; and *branches to the mammary gland* from the arteries in the third, fourth, and fifth interspaces.

The **intercostal veins** correspond in number to the intercostal arteries, the last being called the **subcostal vein**. There is one intercostal vein to each artery; this lies above the artery in each interspace. Near the spinal column the intercostal veins are joined by the veins that accompany the dorsal branches of the intercostal arteries; they return the blood from the muscles of the back, and, by their communication with the spinal plexus of veins, also from the contents of the spinal canal. The intercostal veins are very irregular in their terminations and differ much on the two sides of the body. Between the intercostal muscles they communicate with the tributaries of the internal mammary veins accompanying the anterior intercostal arteries.

The *right superior intercostal vein* accompanies the right superior intercostal artery and empties into the vertebral at its junction with the subclavian vein, or into the innominate vein. Sometimes the veins from the upper two interspaces do not join, but empty separately. The upper vein is then called the *upper right superior intercostal vein*. The vein from the second interspace is in that instance

usually joined by the veins from the third and fourth interspaces, and is known as the *lower right superior intercostal vein*. It empties into the vena azygos major as the latter winds around the root of the right lung. The remaining intercostal veins and the subcostal vein empty into the vena azygos major.

The *left superior intercostal vein* is usually larger than the right, especially when the left upper azygos vein (vena azygos tertia) is absent, and drains the upper four interspaces. Its tributary from the first interspace may empty separately, as on the right side, and then is called the *upper left superior intercostal vein*; the veins from the next three interspaces then unite to form a single trunk which then receives the name of the *lower left superior intercostal vein*, and passes over the arch of the aorta to empty into the left innominate vein. At its lower end it may communicate with the left upper azygos vein, or, in the absence of this vein, pass over the spinal column to empty into the vena azygos major. A thin fibrous cord can usually be seen to connect it to the oblique vein of Marshall, passing through the vestigial fold of pericardium. This is the remains of the fetal **left duct of Cuvier**. The bronchial and superior phrenic veins empty into the lower left superior intercostal veins. The fifth, sixth, and occasionally the seventh intercostal veins either form the upper vena azygos (vena azygos tertia) or empty directly into the vena azygos major. The seventh (sometimes), eighth, ninth, tenth, and eleventh intercostal veins, and the subcostal vein, empty into the vena azygos minor.

The **intercostal nerves** extend along the lower margin of the ribs in the subcostal grooves (below the intercostal arteries), hidden from view on the inner side of the wide outer lip, from beneath which they can, however, be drawn by gentle traction upon their lateral cutaneous branches.

They are eleven in number, and are derived from the anterior divisions of the upper eleven thoracic spinal nerves, the twelfth or last thoracic nerve running below the last rib, after giving off a communicating branch (the dorsi-lumbar nerve) to the first lumbar nerve. The distribution of the last thoracic nerve is similar to that of an intercostal nerve, and has been described with the abdomen. The thoracic nerves are connected by rami communicantes, two to each nerve, with the gangliated cord of the sympathetic, opposite the heads of the ribs. The first thoracic nerve divides, the greater part joining the brachial plexus of nerves, while the smaller, called the first intercostal nerve, is continued along the lower border of the first rib to the angle, where it passes between the external and internal intercostal muscles. It differs from the other intercostal nerves in that, as a rule, it gives off no lateral or anterior cutaneous branches. The posterior divisions of the thoracic nerves pass backward between the transverse processes of the vertebræ, divide into an internal and an external branch, and supply the

muscles and integument of the back. They have been described with the back. The ten remaining intercostal nerves are divided into an upper and a lower set. The upper set includes the anterior divisions of the second, third, fourth, fifth, and sixth, and the lower set the anterior divisions of the seventh, eighth, ninth, tenth, and eleventh thoracic nerves.

DISSECTION.—The internal intercostal muscles should now be carefully incised along the course of the intercostal nerves and the latter exposed.

The **upper intercostal nerves** run outward in the interspaces, at first between the internal intercostal fascia (posterior intercostal membrane) and the pleura, and then between the external and internal intercostal muscles, till the mid-axillary line is reached. Each nerve here gives off a lateral cutaneous branch, which pierces the external intercostal muscle and emerges between the serrations of the serratus magnus muscle. The main trunk of the nerve at this point enters the substance of the internal intercostal muscle and runs in it till the costal cartilage is reached, at which point it passes behind the internal intercostal muscle, lying on the pleura and serrations of the triangularis sterni muscle. After crossing in front of the internal mammary artery it pierces the interspace close to the sternum as the anterior cutaneous nerve. The upper intercostal nerves supply the levatores costarum, serratus posticus superior, external and internal intercostal, infracostal, and triangularis sterni muscles. Each also gives off a lateral cutaneous branch, as before mentioned, and an anterior cutaneous branch. The lateral cutaneous branches vary in size, the second and third being the largest and most important. After piercing the external intercostal muscles, these nerves divide into anterior and posterior branches; the anterior partly supplies the skin over the anterior axillary fold, and gives twigs to the mammary gland; the posterior branches supply the skin over the posterior axillary fold. The lateral cutaneous branch of the second intercostal nerve, or *intercosto-humeral nerve*, communicates with the lesser internal cutaneous nerve, or nerve of Wrisberg of the brachial plexus, and the lateral cutaneous branch of the third intercostal nerve, and is distributed to the upper portion of the internal and posterior surface of the arm. It has been described with the upper extremity. The anterior cutaneous nerves, or terminal branches of the intercostal nerves, pierce the internal intercostal muscles, the external intercostal fascia, and the pectoralis major muscle in company with the perforating cutaneous branches of the internal mammary artery. They supply the skin over the sternum and over almost the entire pectoral region, and give branches to the mammary gland.

The **lower intercostal nerves** differ from the upper only in the part of their course after piercing the interspaces. After emerging from between the costal cartilages they pass into the abdominal wall between the transversalis and internal

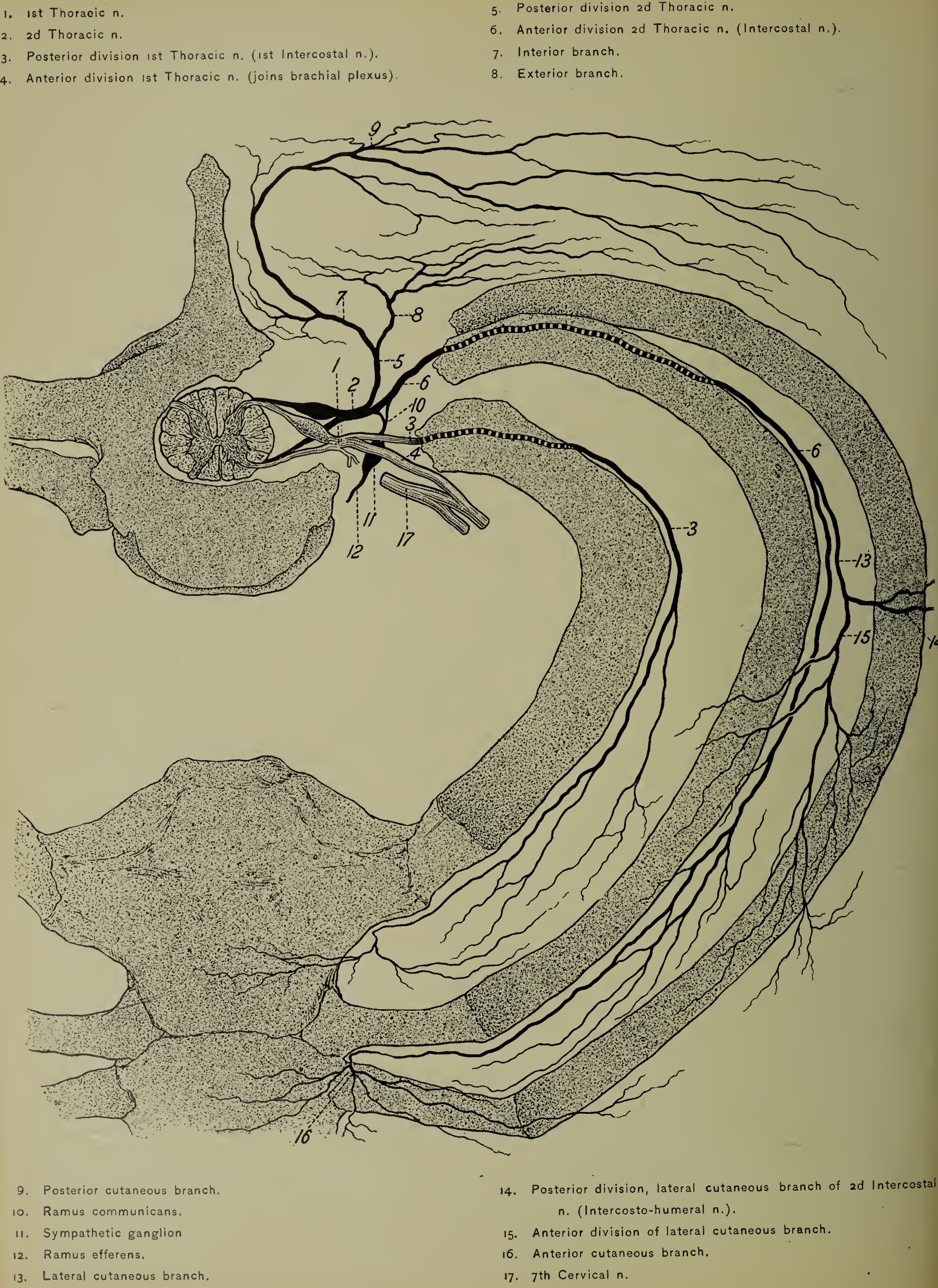
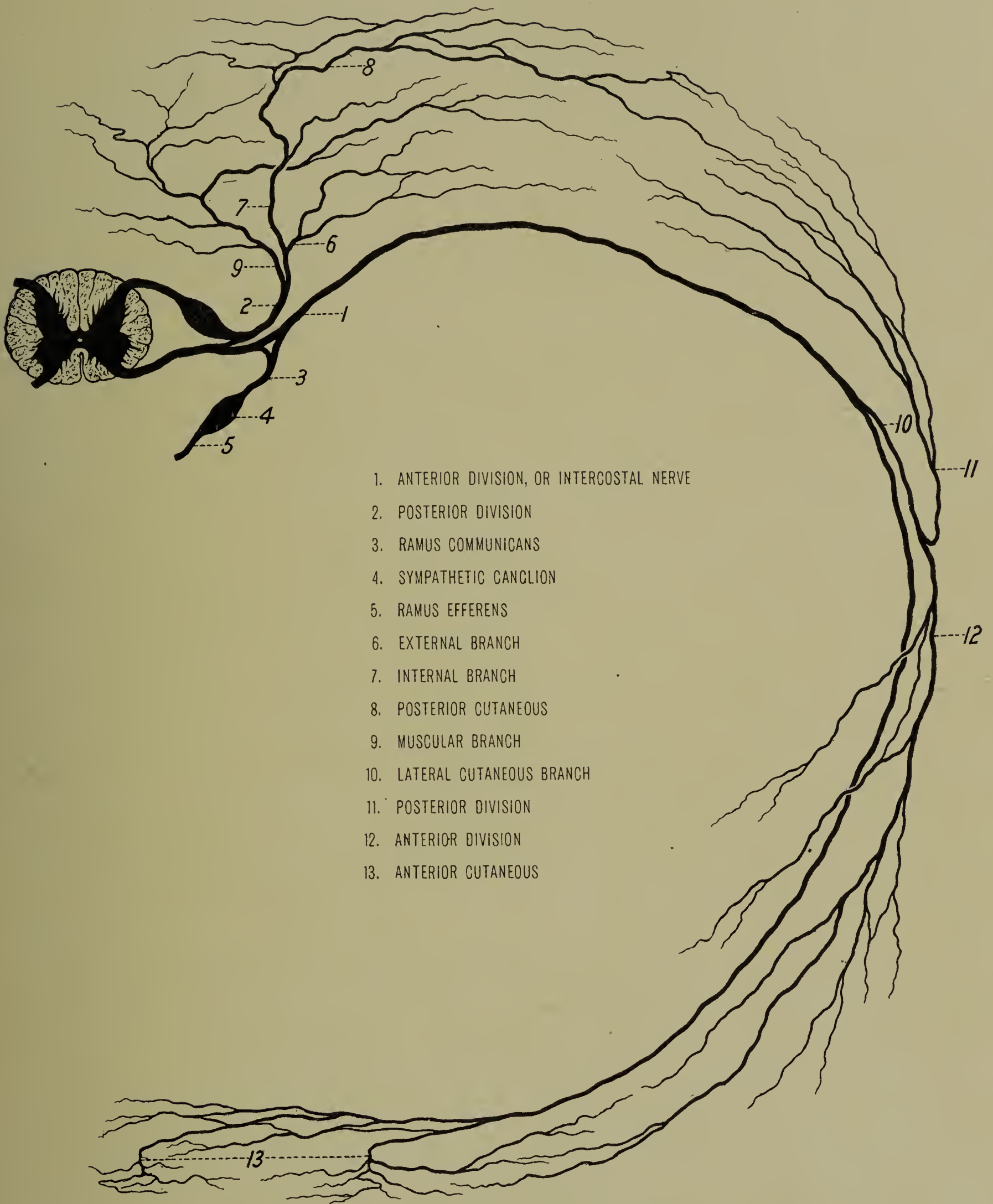


DIAGRAM OF UPPER INTERCOSTAL NERVE.



1. ANTERIOR DIVISION, OR INTERCOSTAL NERVE
2. POSTERIOR DIVISION
3. RAMUS COMMUNICANS
4. SYMPATHETIC CANGLION
5. RAMUS EFFERENS
6. EXTERNAL BRANCH
7. INTERNAL BRANCH
8. POSTERIOR CUTANEOUS
9. MUSCULAR BRANCH
10. LATERAL CUTANEOUS BRANCH
11. POSTERIOR DIVISION
12. ANTERIOR DIVISION
13. ANTERIOR CUTANEOUS

DIAGRAM OF A LOWER INTERCOSTAL NERVE.

oblique muscles, and, after piercing the sheath of the rectus muscle, and supplying that muscle, they terminate as the anterior cutaneous nerves of the abdomen. They supply the integument over the rectus abdominis muscle. The lateral cutaneous branches divide, as do those of the upper intercostal nerves, and supply the integument of the abdomen as far forward as the semilunar line, and that of the back over the loin. They have been described with the abdominal parietes.

The **membranes** or **fasciæ** found in the thoracic wall are the *external intercostal fascia*, also called the *anterior intercostal membrane*, which stretches over the external intercostal muscles, and is thickest where these muscles end—namely, between the costal cartilages over the internal intercostal muscles; the *internal intercostal fascia*, or *posterior intercostal membrane*, which lines the internal intercostal muscles internally and is strongest where they are absent, between the angles of the ribs and the spinal column; the *middle intercostal fascia*, between the intercostal muscles; the *endothoracic fascia*; and the *parietal pleura*.

The name *endothoracic fascia* is given to the fascia that intervenes between the deep surfaces of the ribs and internal intercostal muscles, and the parietal pleura. It splits to cover the infracostal muscles, and is lined internally by the *parietal layer of the pleura*, which will be described with the pleural sac.

The **lymphatics of the thoracic wall** are divided into a superficial and a deep set.

The **superficial lymphatic vessels** ramify over the muscles covering the chest-wall and empty into the axillary glands. Those from the external part of the mammary gland end in the lymphatic glands along the pectoral muscles, while those from its internal portion empty into the internal mammary lymphatic glands by passing through the second, third, and fourth intercostal spaces. Carcinoma of the breast may thus give rise to secondary mediastinal carcinoma of the lymph glands.

The **deep lymphatic vessels** of the chest-wall are the *intercostal* and the *diaphragmatic*. The former accompany the intercostal arteries and empty into the internal mammary lymphatic glands in front, and the intercostal glands behind. The latter accompany the different vessels of the diaphragm and end in the internal mammary and anterior mediastinal lymphatic glands, the posterior mediastinal glands, and, as has already been described under the lymphatics of the abdomen and pelvis, the lumbar glands.

The **superficial lymphatic glands of the chest-wall** are the pectoral lymphatic glands (three or four glands along the under border of the pectoralis major muscle, and described with the upper extremity) and the epigastric gland, below the ensiform cartilage. The former receive some of the lymphatic vessels

from the mammary gland; the latter receives some of those from the anterior portion of the chest-wall.

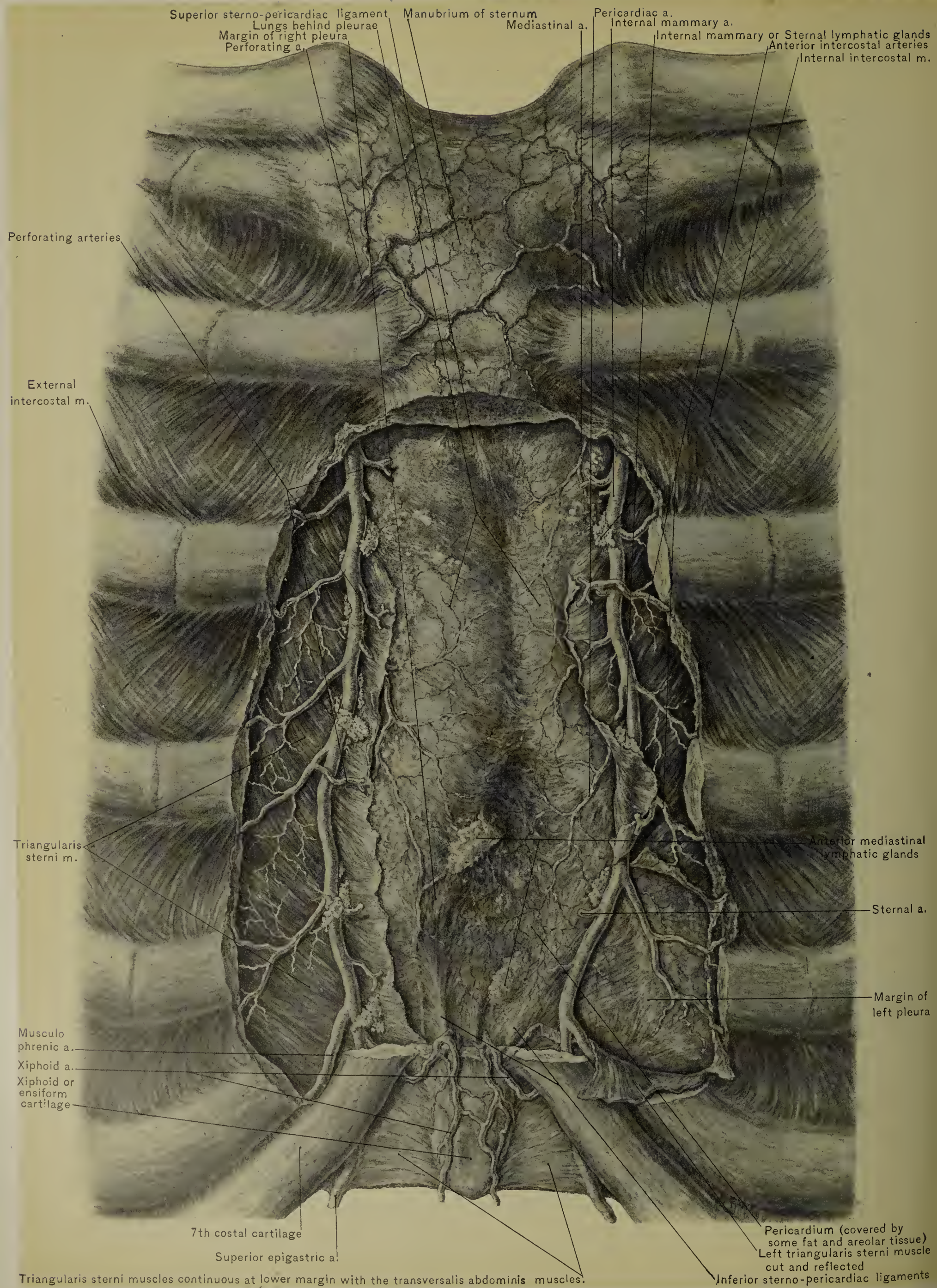
The **deep lymphatic glands of the chest-wall** are the *internal mammary*, also called *external* or *anterior intercostal glands*, and the *posterior intercostal glands*. The former lie along the internal mammary artery, usually one gland in each interspace, and receive the lymphatic vessels from the inner part of the mammary gland, those from the anterior part of the intercostal spaces, and those accompanying the musculo-phrenic and superior epigastric arteries. The efferent vessels from the upper glands empty into the thoracic duct, or the right lymphatic duct, while those from the lower empty into the mediastinal glands. The *posterior intercostal glands* lie opposite the head of the ribs in the posterior part of the interspaces. They receive the lymphatic vessels from the posterior part of the intercostal spaces, the spinal canal, the muscles of the back, and the diaphragm. The efferent vessels from these glands join the thoracic duct. Some of those on the right side, joining the broncho-mediastinal lymphatic vessels, empty into the right lymphatic duct.

THE THORACIC CAVITY.

DISSECTION.—By removing the sternum the cavity of the thorax has been opened. Parts of the left fourth, fifth, sixth, and seventh costal cartilages should now be removed, care being taken not to injure the parietal layer of the pleura and the internal mammary artery. The cut margin of the *triangularis sterni* muscle should be displaced to either side, especially on the left side, to show the deviation of the pleural sacs.

The **Viscera** contained in the **thoracic cavity** are the **lungs**, enveloped in the pleural sacs, and the **heart** within the pericardium. The lungs are placed on either side and the heart between them, but extending further to the left than to the right side.

The interval, or space, between the pleural sacs is called the **Mediastinum**. It extends from the neck to the diaphragm, and is bounded in front by the sternum, behind by the vertebral column, and laterally by the mediastinal portions of the pleural sacs. The space is subdivided into a superior and an inferior compartment in an arbitrary manner, by an imaginary plane passing through the junction of the manubrium and the gladiolus and the lower margin of the body of the fourth thoracic vertebra. This plane slants obliquely upward from before backward, and nearly corresponds to the level of the upper limits of the pericardium. The upper space is called the **superior mediastinum**; the lower space is still further subdivided into the **middle mediastinum**, corresponding to the limits



ANTERIOR MEDIASTINUM.

of the pericardium, and the **anterior mediastinum**, which lies in front of, and the **posterior mediastinum** which lies behind, the pericardium.

The **anterior mediastinum** is opened to view by the removal of the sternum and the fourth, fifth, sixth, and seventh left costal cartilages, which bound it in front. Behind it is bounded by the anterior surface of the pericardium. This space is narrow behind the sternum opposite the second, third, and fourth costal cartilages, but below it grows larger as the left pleural sac diverges to form the notch for the accommodation of the heart, and corresponds to the area of normal cardiac dullness. It therefore extends further to the left than to the right, and contains the portion of the *triangularis sterni* muscle which lies behind the fourth, fifth, sixth, and seventh costal cartilages on the left side; the left internal mammary artery corresponding to the same area; a few lymphatic glands; areolar tissue; the sterno-pericardiac ligaments; and sometimes the lower portion of the thymus gland, or its remains.

The *lymphatics* in the anterior mediastinum are a few small glands that lie in front of the pericardium in the loose areolar tissue of that region, behind the sternum. They receive vessels from the lower internal mammary lymphatic glands, from the anterior surface of the pericardium and the heart, from the middle and anterior portion of the diaphragm, and from the upper surface of the right lobe of the liver. Their efferent vessels empty into the lymphatic glands of the superior mediastinum. A few internal mammary lymphatic glands corresponding to the portion of the left internal mammary artery behind the fourth, fifth, sixth, and seventh costal cartilages can be said to be contained in the anterior mediastinum.

The thymus gland may extend into the upper portion of the anterior mediastinum in young children, but very rarely in adults. This gland, or its shrunken remains, as a rule occupies the superior mediastinal space.

Growths occur more frequently in the anterior mediastinum. The growths may be malignant, as carcinoma (often secondary to carcinoma of the mammary gland) or sarcoma; or benign. Abscesses are likewise quite frequently found, and cysts, such as dermoid and hydatid, more rarely. These growths may give rise to the symptoms and physical signs of aortic aneurysm. An abscess in the anterior mediastinum may follow traumatism, as penetrating wounds, fractures, etc., or it may be secondary to disease of adjacent structures, such as pericarditis, which is probably the most frequent cause. It may discharge through congenital openings in the sternum, or point in the costo-xiphoid angle, or cause bulging of the interspaces close to the sternum. Abscess should be evacuated by trephining the sternum or by resection of a costal cartilage.

The **superior mediastinum** contains the aortic arch and its branches; the innominate veins and the terminal part of their tributaries; the upper portion of

the superior vena cava, trachea, esophagus, and thoracic duct; the pneumogastric, phrenic, and cardiac nerves; the left recurrent laryngeal nerve; the thymus gland, or its remains; and lymphatic glands.

The **middle mediastinum** contains the pericardium, within which are found the heart, the ascending portion of the aorta, the pulmonary artery, and the lower half of the superior vena cava; the phrenic nerves, and the phrenic arteries and their companion veins; the roots of the lungs and the anterior pulmonary plexuses; the termination of the vena azygos major; and some bronchial lymphatic glands.

The **posterior mediastinum** is bounded in front by the posterior surface of the pericardium and the roots of the lungs, and in its lowest portion by the posterior surface of the diaphragm; behind it is bounded by the dorsal spine below the fourth thoracic vertebra. It contains the last part of the aortic arch, and the descending thoracic aorta; the esophagus; the thoracic duct; the azygos veins; the pneumogastric nerves; lymphatic glands; the vertebral portion of the aortic intercostal arteries; the arteria aberrans (when present); the origin of the esophageal, bronchial, pericardiac, and mediastinal arteries; the right lymphatic duct; the great splanchnic nerves; and the posterior pulmonary plexus.

This space is really a continuation downward of the superior mediastinum, many structures from the superior passing into the posterior mediastinum.

DISSECTION.—The connective tissue, fat, lymphatic glands of the anterior mediastinum, and the internal mammary artery should now be removed, thereby exposing the pericardium and the anterior margins of the pleural sacs.

THE PLEURA.

The anterior portion of the **Pleural Sacs**, or **Pleuræ**, are exposed by the removal of the sternum and costal cartilages; they form the lateral limits of the anterior mediastinum. The pleuræ are completely closed serous sacs, one for each lung, the cavities of which do not communicate with each other. Each pleura lines the internal surface of the thoracic wall and at the root of the lung is reflected over the lung and becomes closely and inseparably attached to it. Thus two layers are formed with a space between. The outer, called the **parietal layer**, is attached to the internal surface of the thoracic wall, of which it forms a part; and to the pericardium; to the diaphragm; and, in the neck, to the cervical fascia. It has received different names, according to the part it lines; as, the *costal pleura*; the *diaphragmatic pleura*; the *mediastinal pleura*; and the *cervical pleura*. The inner layer is called the **visceral layer**, and closely invests the lungs. The two layers, it must be remembered, are continuous with each other and are but names given to different parts of the same membrane. The space

between the layers is called the **cavity of the pleural sac**, but normally it does not exist, as the two layers are in contact.

The two pleural sacs are separated above, behind the manubrium sterni; their anterior margins meet at the junction of the first with the second piece of the sternum, a little to the left of the median line, and descend to the fourth costal cartilage, the left usually slightly overlapping the right sac. The anterior margins of the two sacs diverge at this point, the right continuing downward in almost a straight line to the ensiform cartilage; from there it is reflected behind the seventh costal cartilage to the diaphragm. An incision should now be made along the anterior margin of the right pleura large enough to admit the hand, and the extent of the right pleural sac studied from within its cavity. It extends from the seventh costal cartilage downward, outward, and backward, behind the eighth and ninth ribs, reaching the ninth interspace in the midaxillary line; it then passes behind the tenth rib to the eleventh, and, passing along it, reaches the spinal column at the head of the twelfth or last rib.

The left pleural sac differs from the right in that it is narrower and longer. Its anterior margin is seen to deviate outward from the point of contact of the two pleural sacs behind the sternum at the level of the fourth costal cartilage, to form a notch for the heart, leaving a space of irregular outline between the anterior margins of the two pleuræ, called the anterior mediastinum. This has already been described. From the point mentioned the left pleura deviates outward, crossing the fourth interspace obliquely, to a point on the internal surface of the fifth costal cartilage, about one-half inch (1.25 centimeters) away from the left margin of the sternum. From there it continues somewhat obliquely downward and outward to the deep surface of the seventh costal cartilage. Introducing the hand into the cavity of the left pleura, after opening it along its anterior margin, the left pleura is found extending downward and outward behind the seventh costal cartilage, and then crossing the eighth, ninth, and tenth ribs, the lower border of the tenth rib being reached in the midaxillary line. From there the lower margin of the pleura extends backward behind the eleventh rib to the head of the twelfth rib. The limits of the pleural sacs have already been mentioned under Surface Anatomy of the Thorax. In operating on the kidney it should be remembered that the pleura extends down to the last rib at the spine, and therefore care should be taken not to wound the diaphragm or open the pleural sac.

Beyond this the two pleural sacs are quite similar, and therefore do not require separate description. The diaphragmatic attachment of the left pleura is on a lower plane than that of the right, but on neither side does the lung extend as far down as the pleura. Therefore, in the lower portion of the thorax the parietal pleura is not in contact with the visceral pleura, but with the diaphragm.

matic pleura. This part of the pleural cavity is known as the **complemental** or **supplemental pleural space**. From this extreme lower margin the pleuræ are reflected onto the arched diaphragm and extend, mesially, as far as the pericardium (diaphragmatic pleura). Sweeping the hand along the inner surface of the thoracic wall, the parietal layer of the pleura will be found lining it in its entire extent (costal pleura), and even passing upward through the upper opening of the thorax into the neck (cervical pleura) to the extent of one or two inches (2.5 to 5 centimeters), where a process of cervical fascia becomes attached to it (Sibson's fascia). The subclavian artery arches over the cervical pleura, and the scalenus anticus muscle lies in front of it.

The costal pleura is found to be quite thick and tough as compared with the visceral layer, and forms part of the wall of the thorax. It is separated from the internal intercostal and infracostal muscles by the endothoracic fascia. The diaphragmatic pleura is closely attached to the diaphragm and bound down to it by a strong fascia, called the **phrenico-pleural fascia** (Cunningham). It does not, however, reach the costal attachment of the diaphragm, so that a narrow space is left between that muscle and the thoracic wall, known as the **phrenico-costal sinus**.

Owing to the position of the heart, the extent of the diaphragmatic attachment of the left pleura is smaller than that of the right, and its mesial line of reflection further from the sternum than that of the right pleura. By sweeping the hand from the diaphragm toward the median line, the pleura is found to be continued as a partition from the sternum in front to the sides of the bodies of the vertebræ behind, where it becomes continuous with the costal pleura, and to the neck above, where it is continuous with the cervical pleura. It is reflected onto the roots of the lungs, this being its only interruption in its upward extent to become the visceral layer of the pleura, the two layers thus being continuous at the roots of the lungs. This is the mediastinal portion of the parietal layer of the pleura, and forms, on each side, the lateral boundary of the mediastinal space. Its mesial surface comes in close contact with the pericardium and becomes quite adherent to it in the posterior part of its extent. Below the roots of the lungs, in passing the hand along the mediastinal pleura from before backward, a barrier is encountered; this is the **ligamentum latum pulmonis**, which extends from the roots of the lungs to the diaphragm, and is formed by the portions of the mediastinal pleura passing forward from the spine, and backward from the sternum to the sides of the pericardium, and along them to be reflected outward to the lungs, separating there to inclose the lower part of the lungs as the visceral layer. It can be brought to view by drawing the base of the lung outward, when it will appear as a triangular fold of membrane extending

from the lower border of the root of the lung to the diaphragm, supporting the upper part of that structure.

The visceral layer of the pleura envelops the lung and passes into the fissures to cover the lobes, allowing them to glide over each other without friction. When the pleura is normal, the hand introduced between the layers will feel smooth, moist, slippery surfaces. Normally there is no space between the layers, and, but for a small amount of fluid, these two surfaces of pleura are in apposition and glide over each other without friction. Quite frequently, however, bands of adhesions, resulting from some inflammatory process, connect the two layers in different localities; this is particularly liable to occur at the apex. The lobes of a lung are not infrequently adherent to each other from the same causes.

BLOOD SUPPLY.—The pleuræ are supplied by the aortic intercostal, internal mammary, phrenic, inferior thyroid, thymic, pericardiac, and bronchial arteries.

NERVE SUPPLY.—The parietal layer of the pleura is supplied by the intercostal nerves; the visceral layer, by the phrenic nerve and filaments of the sympathetic nerves. It may be noted that the costal pleura is supplied with nerves and vessels from the same sources largely as the chest-wall; the lymphatics also have a similar course; whereas the vascular and nervous supply of the visceral pleura is closely related to that of the lung.

The *lymphatics* of the pleuræ are numerous; those of the parietal pleura pass to the sternal and intercostal glands, while those of the visceral pleura empty into the bronchial glands.

Inflammation of the pleura, known as **pleuritis** or **pleurisy**, causes a roughening of the normally smooth, moist membrane; the movement of respiration then produces the friction sounds that are heard in auscultation of the chest under such conditions. When an effusion of fluid into the pleural sac takes place, the condition is called **hydrothorax**; pus in the pleural sac is called **pyothorax**; **pneumothorax** signifies air in the pleural sac; when air and pus occupy the pleural sac resulting from a pyothorax communicating with a bronchial tube, the condition is known as **pyopneumothorax**; and **hemothorax** means that blood occupies the pleural sac. Fluid in the pleural sac may be removed by **thoracentesis**; *i. e.*, by puncturing the chest-wall and withdrawing the fluid by means of an aspirator. The points for aspirating the chest have been mentioned under Surface Anatomy of the Thorax.

Pus in the pleural sac in neglected cases may evacuate itself by spontaneous rupture, either externally or through the lung, or by rupture through the diaphragm into the abdomen, or by rupture into the pericardium. External rupture may take place through the chest-wall, usually in the fifth intercostal space, or the pus may burrow downward along the spine and appear as a psoas or lumbar

abscess. The rupture through the diaphragm of an appendiceal abscess has caused a localized pyothorax. When pus is present, early evacuation and free drainage are imperative, as collapse of the lung and chest-wall on the affected side is less likely to follow such a course. It is usually necessary to remove a portion of one or more ribs in the infra-axillary region, to obtain free drainage. This operation is known as **thoracoplasty**.

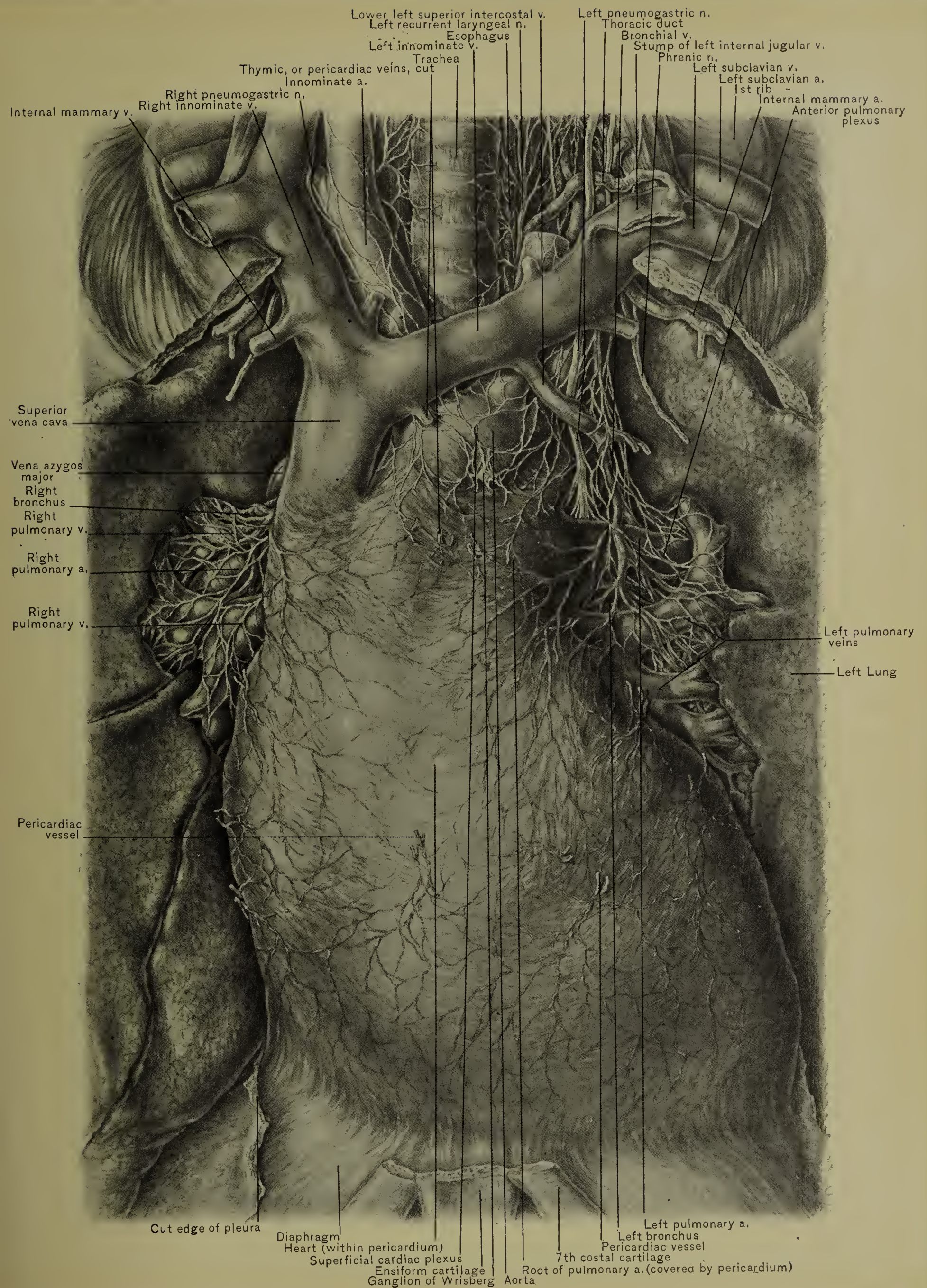
Abscess sometimes forms between the parietal pleura and the chest-wall, and is called **peri-pleuritic**.

The pleura may be the seat of tumors, such as carcinoma, sarcoma, or fibroma. Occasionally they cause bulging of the chest-wall, especially in the interspaces, and may even ulcerate through the tissues. The malignant forms of growths are the more common, and are usually secondary to primary growths of the lungs. Tumors of the pleura, especially when diffuse, give the physical signs of pleural effusion, and cannot be differentiated from the latter till late in the disease.

THE SUPERIOR MEDIASTINUM.

DISSECTION.—The remaining portion of the sternum and first ribs as far outward as the insertion of the scalenus anticus muscle should now be removed. The other ribs, as far down as the seventh or eighth, should be sawed through at about the nipple line, the anterior margin of the lungs displaced outward, and the roots of the lungs and the pericardium exposed on both sides by separating the mediastinal pleura from the pericardium. Its reflection over the roots of the lungs to become the visceral layer of the lungs should be studied, also the **ligamentum latum pulmonis**, which will be seen to extend from the lower border of the roots to the diaphragm, and between the lower portion of the lungs and the sides of the pericardium. A puncture should then be made in a portion of the pericardium, just large enough to admit the small end of a blow-pipe, with which the pericardium may be inflated to demonstrate its extent when filled with serous effusion. An opening should also be made in the trachea, into which a large-mouthed blow-pipe with a stop-cock attached is to be inserted, so that the lungs may be inflated and the relations of their anterior borders demonstrated. The attachments of the cervical fascia to the pericardium should be studied, and the thymus gland or its remains noted. These structures should then be removed and the great vessels and the nerves exposed and cleaned. This exposes to view the structures in the superior mediastinum, which have already been enumerated.

The **thymus gland** is a fetal organ which reaches its full size at the end of the second year, after which it ceases to grow and gradually atrophies. Its function is unknown. When of full size, it is about two inches in length, of a



STRUCTURES IN THE SUPERIOR MEDIASTINUM, AND THE PERICARDIUM AND ROOTS OF THE LUNGS.

grayish color, and consists of two lateral lobes which touch each other along the middle line. In the infant it is situated in the superior mediastinal space and in the neck, extending from the fourth costal cartilage upward as high as the lower border of the thyroid gland, with which it is sometimes connected. I have met with this condition in performing the operation of low tracheotomy. In the superior mediastinum it rests upon the transverse aorta and its branches, and the left innominate vein, being separated from the vessels by the pericardium and the extension of the deep cervical fascia. In the neck it lies on the front and sides of the trachea. In the adult it may either have disappeared or its remains are indicated by a small amount of tissue of a brownish color, largely consisting of fat, lying just above the arch of the aorta, and in front of the innominate, the left subclavian, and the left common carotid arteries. Occasionally the gland may be of considerable size in the adult.

The **Innominate** or **Brachio-cephalic Veins**, right and left, are formed by the union of the subclavian and internal jugular veins of the corresponding side behind the sternal end of the clavicle. They have no valves.

The **left innominate vein**, or **transverse vein**, as it is sometimes called, is longer and larger than the right, being about three inches (7.5 centimeters) in length, and passes from left to right behind the sternal end of the left clavicle, the first portion (manubrium) of the sternum, the sterno-hyoid and sterno-thyroid muscles, the remains of the thymus gland, and the process of the deep cervical fascia continuous with the pericardium, which separates it from that gland. It crosses the left subclavian and left common carotid arteries, the trachea, and the innominate artery, as well as the left pneumogastric, left phrenic, and cardiac nerves to unite with its fellow of the opposite side to form the superior vena cava. The relation the vein bears to the three primary branches of the aorta is to be borne in mind when studying cases of aneurysm of these vessels, under which circumstances the vein may be compressed between the aneurysm and the sternum, thus causing swelling and venous congestion in the parts from which it returns its blood. In some cases the vein passes across the root of the neck in front of the trachea, a fact to be borne in mind in performing a low tracheotomy. Into it empty the vertebral, deep cervical, and inferior thyroid veins from above; the left superior intercostal, the internal mammary, and some of the thymic, mediastinal, and pericardiac veins from below. The thoracic duct empties into it at the junction of the internal jugular and subclavian veins.

The **right innominate** or **brachio-cephalic vein** is the shorter and smaller, being about one and a half inches (3.75 centimeters) in length; it commences behind the inner end of the clavicle and descends vertically to unite with its fellow of the opposite side behind the junction of the first right costal cartilage with the

sternum, to form the superior vena cava. To the outer side are the pleura and lungs, and the right phrenic nerve; to its inner side, and on a plane posterior to it, are the right subclavian and the innominate arteries, the right pneumogastric nerve, and the trachea. In front of it are the remains of the thymus gland, the origin of the sterno-thyroid and the sterno-hyoid muscles, the sternal end of the clavicle, and the first costal cartilages. Behind it are the pleura and lungs. Its tributaries are the vertebral, deep cervical, internal mammary, and inferior thyroid veins, the right lymphatic duct at the confluence of the internal jugular and subclavian veins, and sometimes the superior intercostal vein.

The **Superior or Descending Vena Cava** is formed by the union of the right and left innominate or brachio-cephalic veins, which unite at nearly right angles, opposite the interval between the cartilages of the first and second ribs on the right side of the sternum. It descends vertically, and empties into the upper part of the right auricle. It is invested by pericardium to about an inch and a half (3.8 centimeters) above the heart, and it is this portion that is counted as belonging to the middle mediastinum, the upper portion being contained in the superior mediastinum. It is from two and a half to three inches in length (6.3 to 7.5 centimeters). It has no valves. The superior vena cava is in relation, in front, with the pericardium and with the process of the deep cervical fascia which is continuous with it; the first and second intercostal spaces, the second costal cartilage, and the remains of the thymus gland; the pleura and lungs overlap it. Behind, it is in relation with the right bronchus and the right pulmonary vessels, the vena azygos major, the right pulmonary artery, the superior right pulmonary vein, and the pericardium; on its right side, with the pleura, the lungs, and the phrenic nerve; on its left side, with the ascending aorta and the right innominate artery. Into it empty small pericardiac and mediastinal veins, and the vena azygos major.

The **Vena Azygos Major** for the greater part of its extent occupies the posterior mediastinum, and only as it arches forward and upward over the right bronchus does it become an occupant of the superior mediastinum. It is formed in the abdomen by branches of the lumbar veins, often communicating with the left renal vein, and at times with the inferior vena cava. It enters the thoracic cavity through the aortic orifice of the diaphragm, and from this point to about the level of the fourth dorsal vertebra is an occupant of the posterior mediastinum. There the vein passes forward and winds (from behind forward) over the root of the right lung. At this point it receives the right bronchial vein. It empties into the superior vena cava at the point where the latter becomes invested with the pericardium. It receives blood from the right superior intercostal vein; the right inferior intercostal veins; the vena azygos minor; the vena azygos tertia, when

present; the right bronchial vein; some of the esophageal veins, and a few small pericardiac veins.

Owing to the persistence of the **left duct of Cuvier**, sometimes a left superior vena cava is found, which empties into the coronary sinus. The **oblique vein of Marshall** is the remains, in the adult, of this fetal duct; it communicates with the left lower intercostal vein, and passes, as a thin fibrous band, through the vestigial fold of pericardium to end in the coronary sinus.

The Phrenic Nerves.—Before opening the pericardium, the relations of the phrenic nerves are to be studied. Both nerves are at first occupants of the superior mediastinum, but between the pericardium and pleura they lie in the middle mediastinum. Each nerve usually arises by three roots from the anterior divisions of the third, fourth, and fifth cervical nerves; occasionally it has only two roots, and sometimes but one, that from the fourth cervical nerve. The filament from the fifth cervical nerve is commonly derived from the nerve to the subclavius muscle or from the communicating branch from the cervical plexus to the brachial plexus. After receiving a twig from the cervical sympathetic the phrenic nerve on either side runs obliquely downward and inward over the scalenus anticus muscle and enters the chest through its upper opening behind the subclavian vein, crossing the internal mammary artery at its beginning, from without inward. There it is usually joined by the root from the fifth cervical nerve. The **right phrenic nerve** then runs downward along the right side of the right innominate (brachio-cephalic) vein, the superior vena cava, and the pericardium, and between these structures and the pleura, to reach the diaphragm. The **left phrenic nerve** passes in front of the arch of the aorta and the cervical cardiac branch of the vagus, and between the pericardium and pleura, to the diaphragm. Both nerves cross in front of the roots of the lungs and enter the middle mediastinum. Upon reaching the diaphragm they pierce it and ramify on its under surface, and supply it. The left phrenic is longer than the right owing to the greater inclination of the pericardium and heart toward the left side and to the fact that the diaphragm is lower on the left side. Each nerve distributes branches to the pericardium and pleura and communicates with the sympathetic and other nerves. On the right side one or two filaments join with the diaphragmatic branches of the solar plexus to form a small ganglion (ganglion diaphragmaticum), from which branches are distributed to the hepatic plexus, the suprarenal capsule, and the inferior vena cava. From the left phrenic, filaments pass to join the left diaphragmatic plexus. Luschka suggests that various respiratory disturbances, paralysis of the diaphragm, and certain forms of hiccup may be due to interference with the function of the phrenic nerve by means of adhesions of the pericardium and pleura.

Inasmuch as filaments from the right phrenic pass to the substance of the liver through the coronary and falciform ligaments, it is likely that the right shoulder pain in hepatic disease is due to this distribution, producing false sensory reference. Each phrenic nerve is accompanied by the **comes nervi phrenici artery**, a branch of the internal mammary artery, which has been described with that vessel.

Galvanization of the phrenic nerve is effected by placing one electrode over the nerve as it crosses the scalenus anticus muscle, the sterno-mastoid muscle being displaced inward to permit it; while the other electrode is placed over the costal attachment of the diaphragm.

The Pneumogastric Nerves.—The **right pneumogastric nerve** passes between the subclavian vein and the first portion of the subclavian artery, enters the chest through its superior opening, and descends in the superior mediastinum behind the right innominate vein on the right side of the trachea to the posterior surface of the root of the right lung, where it becomes an occupant of the posterior mediastinum. Behind the bronchus it becomes broad and flat and supplies several branches to the right posterior pulmonary plexus. Thence the nerve descends as two cords upon the right side of the esophagus, where it gives off numerous branches which inosculate with similar branches from the left nerve. These branches of both pneumogastrics ramify on the anterior and posterior surfaces of the esophagus and form the *plexus gulæ*, or *esophageal plexus*. Beyond this plexus, the right pneumogastric nerve continues as a single cord on the posterior surface of the esophagus to enter the abdomen through the esophageal opening of the diaphragm. It is then distributed to the posterior surface of the stomach and supplies branches to the celiac, splenic, and left renal plexuses. The **left pneumogastric nerve** enters the chest at its superior opening, between the left common carotid and the left subclavian arteries and behind the left innominate vein. It descends in the superior mediastinum between the left common carotid and the left subclavian arteries, and, bending backward, crosses in front of the left side of the transverse portion of the arch of the aorta, and passes to the posterior surface of the root of the left lung, where it becomes an occupant of the posterior mediastinum. From this point, its course is similar to that of the right pneumogastric. It supplies branches to the left posterior pulmonary plexus; descends as two cords on the left side of the esophagus; assists in the formation of the esophageal plexus; then, as a single trunk, descends on the anterior surface of the esophagus and passes through the esophageal opening of the diaphragm. It is distributed to the anterior surface of the stomach and supplies branches to the hepatic plexus.

In the chest, in addition to those mentioned above, each nerve gives off

branches to the anterior pulmonary plexus and the deep cardiac plexus, and the recurrent laryngeal nerve.

The **right recurrent** or **inferior laryngeal nerve** is given off as the pneumogastric nerve crosses the first portion of the subclavian artery, winds around that vessel, and passes upward, behind the common carotid and inferior thyroid arteries, to gain the side of the trachea. It then runs upward in the groove between the trachea and the esophagus and enters the larynx behind the lower border of the inferior constrictor of the pharynx. It gives off a branch to the cardiac plexus at its commencement.

The **left recurrent** or **inferior laryngeal nerve** arises from the left pneumogastric in front of the transverse aorta, and winds, from before backward, around the aorta below the attachment of the ductus arteriosus. It then ascends by the side of the trachea, where it lies in the groove between the trachea and the esophagus, along which it passes to be distributed like its fellow of the opposite side. In aneurysm of the arch of the aorta this nerve is subjected to pressure, giving rise to laryngeal disturbances. Both nerves have been described with the neck.

The pneumogastric nerves give off superior and inferior cervical cardiac and thoracic cardiac branches. The **superior cervical cardiac branches**, usually two in number, join the superior cardiac nerves of the sympathetic, and will be further described with the cardiac plexuses. The **right inferior cervical cardiac nerve** runs downward on the side of the trachea and enters the deep cardiac plexus. The **left inferior cervical cardiac nerve** joins the anterior or superficial cardiac plexus. It passes in front of the arch of the aorta, and between it and the pleura, lying behind the phrenic nerve and in front of the left superior cervical cardiac nerve of the sympathetic. The **thoracic cardiac nerves** are usually given off from the inferior or recurrent laryngeal nerves near their origin, and end in the deep cardiac plexus.

The **pulmonary branches** are the **anterior**, a few small twigs given off above the root of the lung, and which unite with branches of the sympathetic in front of the bronchi to form the anterior pulmonary plexuses; and the **posterior**, which result from the breaking up of the pneumogastric nerves into a network behind the bronchi, forming the posterior pulmonary plexus.

Besides these, the pneumogastric nerves give off meningeal, auricular, pharyngeal, and superior laryngeal branches that have been described with the head and neck.

The **Cervical Cardiac Branches** of the sympathetic are three in number upon each side—superior, middle, and inferior.

The **superior cardiac nerve** arises from the superior cervical ganglion of the

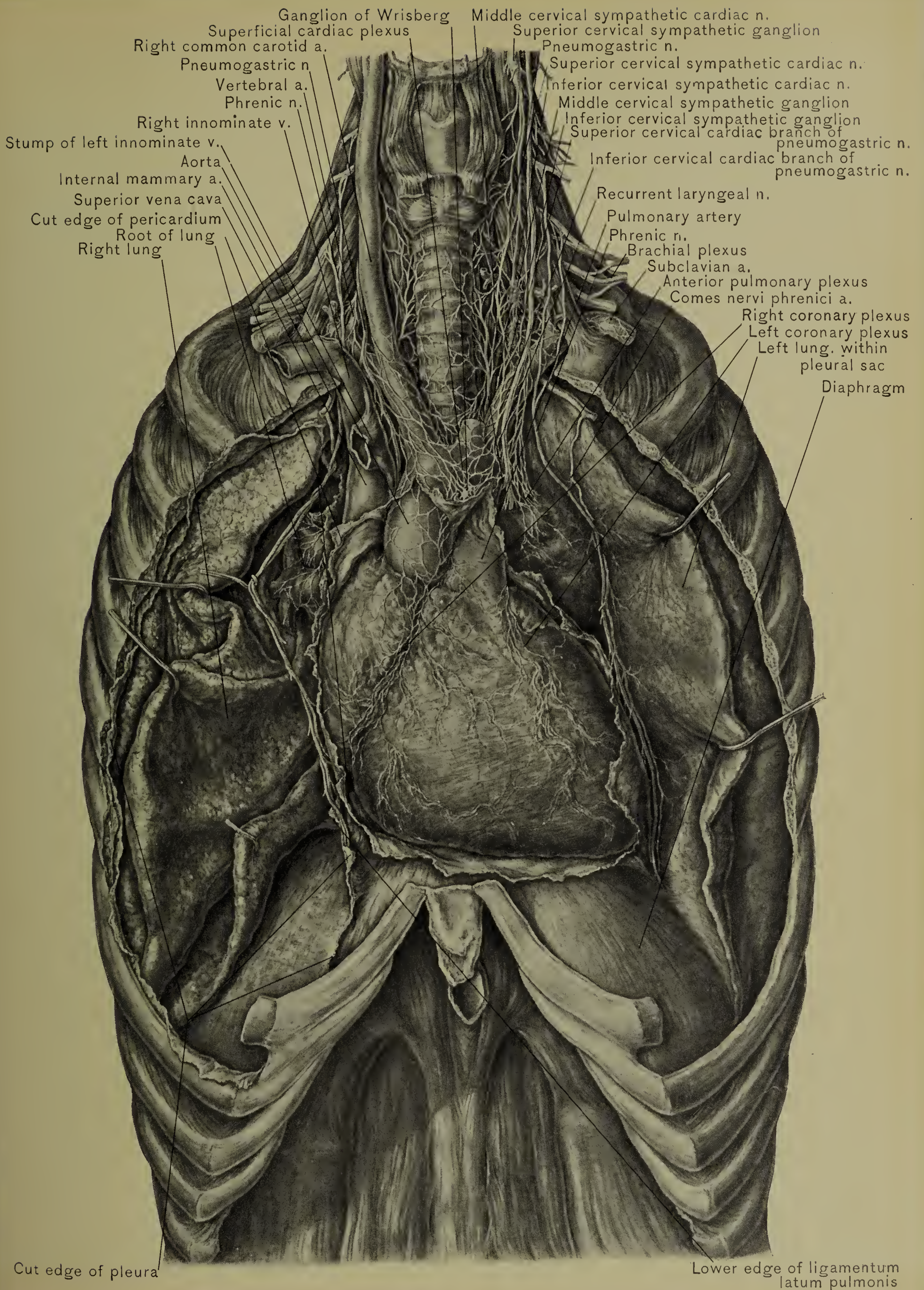
sympathetic and sometimes from the sympathetic cord between the superior and middle cervical ganglia. Both nerves are similar in the neck, but in the thorax they differ on the two sides; they pass downward upon the prevertebral fascia in front of the longus colli muscle, behind the common carotid artery, and anterior to the inferior thyroid artery and the recurrent laryngeal nerve, communicating with the upper cervical cardiac branch of the pneumogastric nerve, the middle cervical cardiac branch, and both the external and recurrent laryngeal nerves, and send filaments to the thyroid gland along the inferior thyroid artery. Beyond this point the course of the nerves on the two sides is different. Upon the right side the nerve passes either in front of or behind the subclavian artery, and thence along the innominate artery to the deep cardiac plexus behind the aortic arch. Upon the left side it lies to the left of the common carotid artery, and passes in front of the transverse portion of the aortic arch between the pneumogastric nerve and its inferior cervical cardiac branch to join the superior cardiac plexus.

The **middle cardiac nerve**, the largest, arises from the middle cervical ganglion, or the sympathetic cord between the middle and inferior ganglia. On the right side it descends behind the common carotid, either in front of or behind the subclavian artery, to the trachea, on which it receives some filaments from the recurrent laryngeal nerve, and passes downward to join the deep cardiac plexus. The left middle cardiac nerve enters the chest between the common carotid and subclavian arteries to join the deep cardiac plexus. On both sides these nerves, while in the neck, communicate with the superior cardiac nerve, and in the thorax with the recurrent laryngeal nerves.

The **inferior cardiac nerve**, beginning at the inferior cervical or first thoracic ganglion, which ganglia are commonly fused, passes behind the subclavian artery and thence upon the side of the trachea to the deep cardiac plexus, communicating with the recurrent laryngeal and middle cardiac nerves.

The **Cardiac Plexus** is formed by the cervical and thoracic cardiac branches of the pneumogastric nerves, the cardiac branches of the recurrent laryngeal nerves, and the cardiac branches of the sympathetic. It is divided for convenience of description into a superficial and a deep plexus, although it consists of a continuous network of nerves.

The **superficial cardiac plexus** (anterior) is a small network of nerves in front of the right pulmonary artery below the aortic arch and internal to the ductus arteriosus. It is formed by the left superior cardiac sympathetic nerve, the inferior cervical cardiac branch of the left vagus (and sometimes also of the right), and branches from the deep cardiac plexus. At times a small ganglion (**cardiac ganglion of Wrisberg**) is found at the junction of these nerves. The dissection of the plexus must be made in a very good light, with the assistance of a good hand



STRUCTURES IN THE SUPERIOR MEDIASTINUM, AND THE HEART AND LUNGS.

magnifying glass to aid in tracing the nerve filaments. Small branches can be traced to the right coronary plexus and to the left anterior pulmonary plexus which lies in front of the left bronchus.

The **right coronary plexus** begins between the pulmonary artery and aorta, whence it extends forward on the right coronary artery; it is composed of filaments from the deep cardiac plexus and (mainly) from the superficial cardiac plexus.

The **great or deep cardiac plexus** is found upon the front of the bifurcation of the trachea behind the arch of the aorta and just along the division of the pulmonary artery; it is formed by all of the cardiac nerves of the right pneumogastric and cervical sympathetic nerves, the middle and inferior cardiac branches of the left cervical sympathetic, the thoracic cardiac branch of the left pneumogastric nerve, and the cardiac branches of the recurrent laryngeal nerves; the cardiac nerves not aiding in its formation being the left superior cervical cardiac branch of the sympathetic, and the superior and inferior cervical cardiac branches of the left pneumogastric, which form the anterior cardiac plexus. This great plexus forms the left coronary plexus and a lesser portion of the right coronary plexus, some of its branches going to the anterior pulmonary plexuses and the cardiac auricles. Some of its branches on the right side pass in front of those behind the right pulmonary artery, the former going to the anterior pulmonary and the right coronary plexuses, and the latter, to the right auricle and left coronary plexus. On the left side its branches go to the left auricle and anterior pulmonary plexus, after which they send a few filaments to the superficial cardiac plexus, and continue backward to form the left coronary plexus.

The **left coronary plexus** passes between the left auricular appendix and the pulmonary artery to the left coronary artery, the branches of which its filaments follow to supply the heart muscle. It is formed by branches from the right and (mainly) the left side of the great cardiac plexus, and is continuous with the deep cardiac plexus.

Careful examination of the sub-pericardial heart surface and of its substance will reveal many sympathetic ganglia and fibers.

The **Pulmonary Plexuses** are found upon the root of each lung. The plexuses in front are called the **anterior**, and are formed by branches of the pneumogastric (anterior pulmonary) and sympathetic filaments. The plexuses behind are called **posterior**, and are also formed by branches of the pneumogastric (posterior pulmonary) which are much larger than the anterior branches, and which unite with branches from the second, third, and fourth thoracic sympathetic ganglia. These plexuses send filaments along the bronchi for distribution to the entire lung substance.

DISSECTION.—The right innominate or brachio-cephalic vein and its relations having been studied, this vessel is now to be severed and reflected, thus exposing the great arch of the aorta, appearing in the upper part of the cavity of the thorax (superior mediastinum) like the crook of a shepherd's stick. It should be cleaned of its loose connective-tissue covering, care being taken not to sever the left phrenic and the left pneumogastric nerves and the cardiac nerves to the superficial cardiac plexus, which pass downward in front of the arch of the aorta. Puncture of the pericardium should be avoided at this stage, as it is advisable to occasionally inflate this sac so as to define its upper outlines.

The **Thoracic Aorta** is divided for examination and description into three parts—*ascending aorta*, *transverse aorta*, or *aortic arch*, and *descending aorta*. It begins at the conus arteriosus of the left ventricle, where it is overlapped, on its left side, by the origin of the pulmonary artery, and, on the right side, by the appendix of the right auricle. Its origin is opposite the middle of the sternum on a level with the lower border of the third sterno-chondral junction. The ascending aorta passes upward, forward, and to the right, in the line of the heart's axis, as high as the upper margin of the second right costal cartilage. It extends slightly beyond the right border of the sternum at this point, where it is overlapped by the right pleura and the anterior margin of the right lung, and here the transverse aorta, or aortic arch, begins. From this point the transverse aorta passes transversely across the chest cavity and obliquely backward from right to left to the left side of the fourth thoracic vertebra. These parts, with the exception of the portion of the ascending aorta that is covered by pericardium, and which belongs to the middle mediastinum, are contained in the superior mediastinum. Thence, as the descending thoracic aorta, it passes downward on the left side of the bodies of the vertebræ, gradually approaching the median line, and then passing through the diaphragm to become the abdominal aorta. This part is contained in the posterior mediastinum.

The **ascending aorta** with the pulmonary artery is largely covered by the fibrous layer of the pericardium. The part covered by pericardium is contained in the middle mediastinum; the remainder is located in the superior mediastinum. It is considerably bulged in front and toward the right, just where its walls receive the direct impact of the column of blood forced out of the powerful left ventricle. This dilated or "bulged" portion is known as the **sinus of the aorta**. It is the part of the aorta which receives the greatest strain and which is generally the first to show atheromatous changes. It is, therefore, a favorable site for aneurysmal dilatation. The origin of the aorta at its ventricular attachments shows three little bellies externally: two are in front—one on the right and the other on the left side, the latter being behind the pulmonary artery; the third

belly is on the posterior surface. They are called **sinuses of Valsalva**, and mark the location of the aortic semilunar valves. From the two anterior, right and left, arise the right and left coronary arteries. This portion of the aorta, together with the pulmonary artery, is invested by an extension of the pericardial covering of the heart. Anterior to the beginning of the ascending aorta are the pulmonary artery and right auricular appendix. Higher up, the pericardium, connective tissue, the remains of the thymus gland, the right pleura, and the thin margin of the right lung separate it from the sternum. Behind it are the right pulmonary artery, the left auricle, and the right deep cardiac nerves; on its right side it abuts against the right auricle and the superior vena cava; on its left side it is in relation with the pulmonary artery and branches of the right and left superficial cardiac nerves.

The **transverse aorta**, or **aortic arch**, extends to within an inch of the supra-sternal notch and may, at times, in thin persons, be felt or even seen pulsating at the bottom of the supra-sternal fossa. From its upper border arise, from right to left, the innominate, the left common carotid, and the left subclavian arteries. It is partly covered by the left pleura and lung, and to a less extent by the right pleura and lung. It is crossed by the left phrenic nerve, the left pneumogastric nerve and its cardiac branches, the left superior cardiac branch of the sympathetic nerve, and the terminal part of the left superior intercostal vein; behind it lie the trachea, the deep cardiac plexus, the esophagus, the thoracic duct, and the left recurrent laryngeal nerve; above it are its three great branches and the left innominate vein; below it, in the concavity of the arch, are the divisions of the pulmonary artery, the remains of the ductus arteriosus, the left recurrent laryngeal nerve, as it winds around the arch from before backward, the superficial cardiac plexus, the left bronchus, and some lymphatic glands.

The **descending thoracic aorta**, beginning at the lower border of the fourth dorsal vertebra, lies in the posterior mediastinum and is covered in front by the pleura and root of the left lung and pericardium. Behind, it lies against the spine, at first on the left side of the bodies of the vertebræ, and then approaches the median line. On its right side are the esophagus, thoracic duct, and vena azygos major; at the lower portion of the chest the esophagus is anterior and to the left of the aorta. Its left side is in relation with the pleura.

In consequence of the oblique position of the aortic arch, the left pneumogastric nerve, left phrenic nerve, left bronchus, and left pulmonary vessels pass in front of the arch; on the right side these structures pass behind it. In the above description of the aorta, the terms "ascending, transverse, and descending portions of the aortic arch" have been discarded for the more accurate and appropriate terms, "ascending aorta," "transverse aorta, or aortic arch," and "descending thoracic aorta."

In this connection the student may well consider some of the symptoms produced by aneurysmal dilatation of the various portions of the thoracic aorta, inasmuch as a number of these symptoms are due to pressure upon adjacent structures.

If the aneurysm involve the artery in the neighborhood of the sinuses of Valsalva, rupture into the pericardial cavity may occur.

An aneurysm involving the ascending aorta along the right anterior wall, as it often does, grows toward the right pleura, and also forward; the superior vena cava may be compressed, leading to engorgement of the veins of the head and arm; perforation into the cava may occur, or it may burst into the pericardium, right pleural cavity, trachea, bronchus, or esophagus.

Very often aneurysm of the ascending aorta causes erosion of the sternum and costal cartilages and forms a bulging, pulsating mass in this situation, which may rupture externally.

Aneurysm of the transverse aorta may also erode the sternum, though perhaps more commonly it causes pressure on the trachea and esophagus, leading to dyspnea, dysphagia, cough, hemoptysis, etc.; or the thoracic duct may be compressed, leading to failure of nutrition. Irritation of the left recurrent laryngeal nerve may lead to laryngeal symptoms; pulsation in the supra-sternal notch is frequently met with in dilated aorta, though it must be borne in mind that such pulsation may be due to the innominate artery. Inequality of the pulse in the carotids or radials may result from involvement of the great vessels which come from the arch, or from their obstruction by clots. Symptoms referable to pressure upon the sympathetic, vagus, and phrenic nerves may be encountered.

Aneurysm of the descending aorta often causes severe pain from pressure on the intercostal nerves or from erosion of the vertebræ; pressure on the azygos and intercostal veins may lead to dilatations of the tributaries of these veins. The aneurysm may bulge externally in the mid-scapular region; rupture into the esophagus, left pleural cavity, or air-passages may occur.

The Coronary Arteries.—The first branches given off from the aorta are the right and left coronary arteries; they arise from the commencement of the ascending aorta and supply the muscular tissue of the heart. The **left or anterior coronary artery** arises from the left anterior sinus of Valsalva above the edge of the left anterior semilunar valve. It passes forward between the pulmonary artery and the appendix of the left auricle to the junction of the auriculo-ventricular with the anterior interventricular groove. The **right coronary artery** arises from the right anterior sinus of Valsalva immediately above the free border of the right anterior semilunar valve. It passes forward

between the pulmonary artery and the appendix of the right auricle; it then turns to the right, running in the auriculo-ventricular groove to its junction with the posterior interventricular groove. The further course of these vessels will be described with the heart.

The **Innominate Artery** (brachio-cephalic) is the first and largest of the three great branches of the transverse aorta. It is also the shortest of these vessels, being from one and a half to two inches (3.8 to 5 centimeters) in length. From its origin at the beginning of the transverse aorta or aortic arch it passes upward and outward to the upper margin of the right sterno-clavicular joint, behind which it divides into the right common carotid and right subclavian arteries. It lies behind the right side of the manubrium sterni, the lowest part of the sterno-hyoid and sterno-thyroid muscles, the remains of the thymus gland, the left innominate vein, and the right inferior thyroid vein, and the right inferior cervical cardiac branch of the pneumogastric nerve. The right inferior thyroid vein and the left innominate vein cross the artery near its origin. It crosses obliquely in front of the trachea. Upon its left side are the root of the left common carotid, the remains of the thymus gland, the trachea, and the right inferior thyroid vein near the bifurcation of the artery. Upon its right side are the right innominate vein, the right pneumogastric nerve, and the pleura. The innominate artery gives off no branches, except occasionally the anomalous **thyroidea ima**, which usually ascends upon the front of the trachea to the thyroid gland. More rarely it may give origin to the vertebral, the internal mammary, or a bronchial, thymic, pericardiac, or tracheal branch. It may bifurcate lower than normal, thereby increasing the length of the first portion of the right subclavian artery; or it may divide higher than normal; in such a case it would be unusually long, and may then run upward and outward in front of the trachea, when it may be cut in the operation of low tracheotomy; or it may run behind the trachea or esophagus.

The innominate artery has been tied a number of times for subclavian aneurysm, but the operation has been almost uniformly followed by death, most often from secondary hemorrhage; consequently it is advised by some surgeons to tie the right common carotid and vertebral arteries, simultaneously with the innominate, in order to lessen the danger of hemorrhage. To reach the artery, the head is drawn backward, the shoulder depressed, and an incision three inches (7.5 centimeters) long made along the anterior border of the sterno-mastoid muscle to the sterno-clavicular articulation, and from there outward along the inner one-third of the clavicle. After division of the integument, superficial fascia, and platysma myoides muscle, the triangular flap is turned outward and a director is passed beneath the origin of the sterno-mastoid and the sternal portion of that muscle is divided; then the sterno-hyoid and sterno-thyroid muscles are divided on a direc-

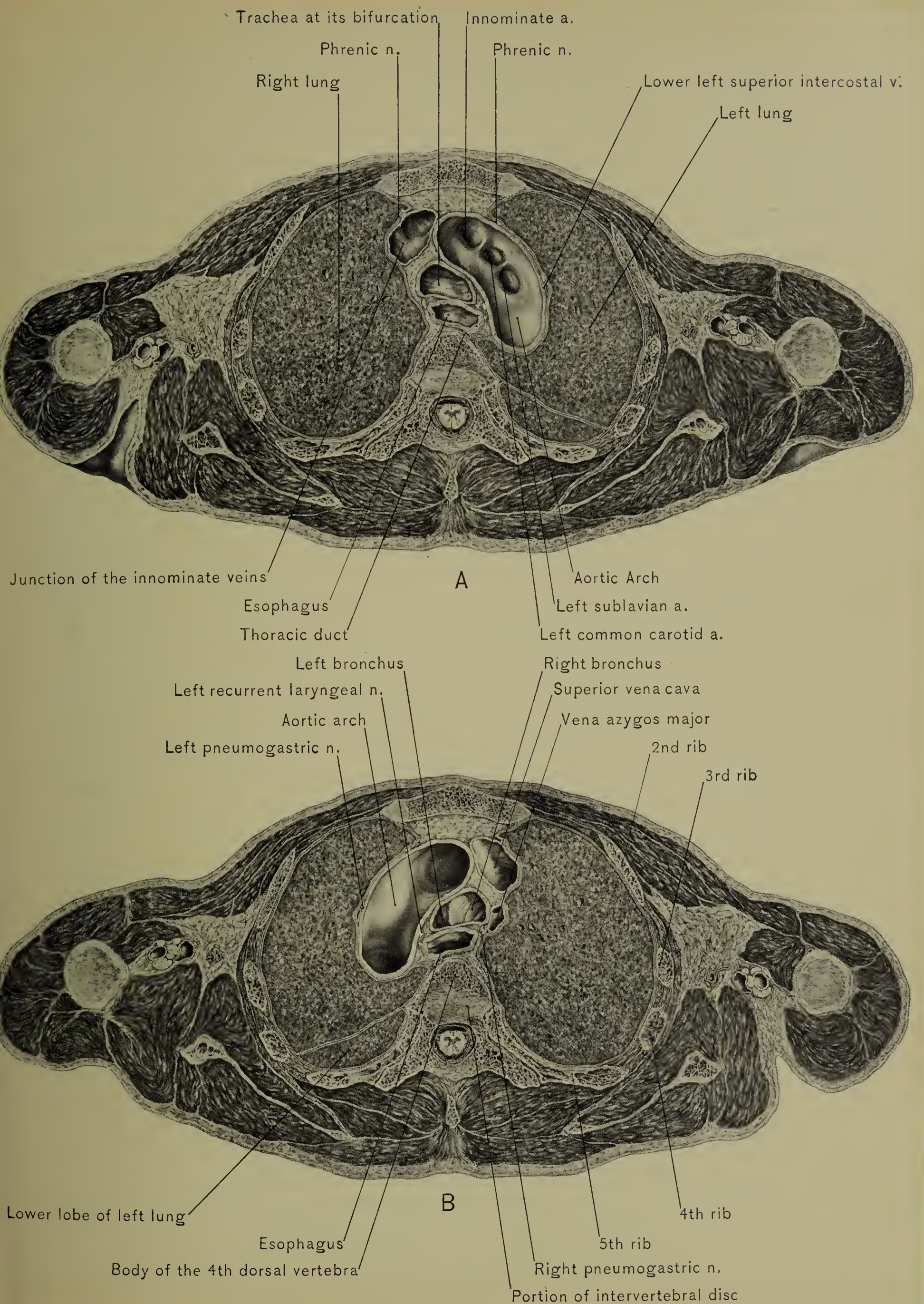
tor, near their sternal attachments; any veins that are encountered—as, for instance, the inferior thyroid or anterior jugular—are divided between two ligatures. The carotid sheath should then be opened, exposing the common carotid artery, which is traced downward to its origin from the innominate; the right innominate and internal jugular veins and the vagus nerve are drawn to the right and the left innominate vein is pushed downward. With a curved aneurysm needle the ligature is passed round the artery, from without inward and from below upward, care being taken not to injure the right pleural sac, nor to include any of the cardiac branches of the sympathetic.

The **Left Common Carotid Artery** arises from the aortic arch, just to the left of the innominate. It passes upward and to the left, reaching the root of the neck behind the left sterno-clavicular articulation, after which its course and relations nearly correspond to those of the right common carotid. The left common carotid artery can be conveniently described as consisting of two portions—the first or thoracic, and the second or cervical portion. The course of the thoracic portion having been given, it remains to describe its relations. In front of it are the origins of the left sterno-hyoid and sterno-thyroid muscles, crossing its root is the left innominate vein, and the remains of the thymus gland and the fat and areolar tissue of the superior mediastinum intervene between it and the sternum. Behind it are the trachea, the esophagus, the thoracic duct, and the left recurrent laryngeal nerve; on its right side are the innominate artery, left inferior thyroid veins and part of the remains of the thymus gland, and the trachea. On their outer side are the left vagus nerve, left pleural sac, and the lung; the left subclavian artery is also on the outer side, but slightly posterior to the left common carotid artery.

The left common carotid artery may vary in the manner of its origin; thus, it may be given off from a stem common to it and the right common carotid and subclavian arteries, and in that case it may cross the trachea obliquely and may be wounded in low tracheotomy. This is the most common of the variations of this artery, and was formerly described as the normal arrangement in man.

The **Left Subclavian Artery**, the third great branch springing from the aortic arch, arises a little to the left of and somewhat behind the left common carotid from the aortic arch, and passes vertically upward. After arching over the apex of the left pleura and lung, it passes behind the scalenus anticus muscle at its insertion into the first rib. This constitutes the first part of the artery. From there on, both subclavian arteries are alike. Like the left common carotid artery, it may be divided into a thoracic and a cervical portion; the thoracic portion gives off no branches.

In front, it is covered by the left pleura and lung, the origins of the sterno-hyoid, sterno-thyroid, and sterno-mastoid muscles; the left vagus, phrenic, and



CROSS-SECTION OF THE THORAX THROUGH THE SUPERIOR MEDIASTINUM.

(A) FROM BELOW. (B) FROM ABOVE.

cardiac nerves, and the left internal jugular and innominate veins are also in front of it, the latter crossing its root. At the inner border of the scalenus anticus muscle the thoracic duct arches over the artery to empty at the junction of the internal jugular and subclavian veins. The phrenic nerve crosses the artery at the inner border of the scalenus anticus muscle and then runs downward parallel with the artery, but on a plane a little in front of it. The left pneumogastric nerve lies to the inner side of the artery, but between it and the left common carotid, crossing the root of the left subclavian artery just before crossing the arch of the aorta.

This artery likewise may vary somewhat in its origin, being sometimes given off from a left innominate artery or from a common trunk for the right and left common carotids and the left subclavian artery. Behind it are the esophagus, the thoracic duct, the inferior cervical ganglion of the sympathetic, the longus colli muscle, and the bodies of the vertebræ. On the outer side are the left pleura and lung. On the inner or median side are the trachea, esophagus, thoracic duct, and left recurrent laryngeal nerve.

The **Pulmonary Artery**, although belonging to the middle mediastinum, will be described now for convenience. It is wide and short, and arises from the conus arteriosus of the right ventricle, in front of the origin of the aorta, whence it ascends for about one and a half inches (3.8 centimeters) to divide into two lateral arms, the right and the left pulmonary arteries, to be distributed to the lungs. It is invested with a visceral and a parietal layer of pericardium, like the aorta, and is separated from the sternum by mediastinal connective tissue, and sometimes by lung and pleura. Upon its right side, at its origin, are the right coronary artery, the right auricular appendix, and the ascending aorta; upon its left side, at its origin, are the left coronary artery, the left auricular appendix, and the left pleura and lung. The ascending aorta is behind it below, and the left auricle higher up; above, it divides under the transverse aorta, with which it is connected by the remains of the ductus arteriosus, at a point a little to the left of its division. Its direction is upward, backward, and to the left.

The **right pulmonary artery**, the longer, passes directly outward under the aortic arch and behind the ascending aorta and the superior vena cava to the root of the right lung, there to divide into a large upper branch to the upper lobe, which gives off a branch to the middle lobe, and a smaller lower branch to the lower lobe. The right pulmonary artery is at first in relation in front with the ascending aorta, the vena cava superior, the phrenic nerve, the anterior pulmonary plexus, and the pleura; behind, with the right bronchus; above, with the aortic arch; and below, with the left auricle and the pulmonary veins. At the root of the lung the right bronchus is above and behind, and the pulmonary veins

below and in front of, the right pulmonary artery. These branches run the same course as the bronchi and are distributed to the lung tissue. Their terminal branches do not anastomose.

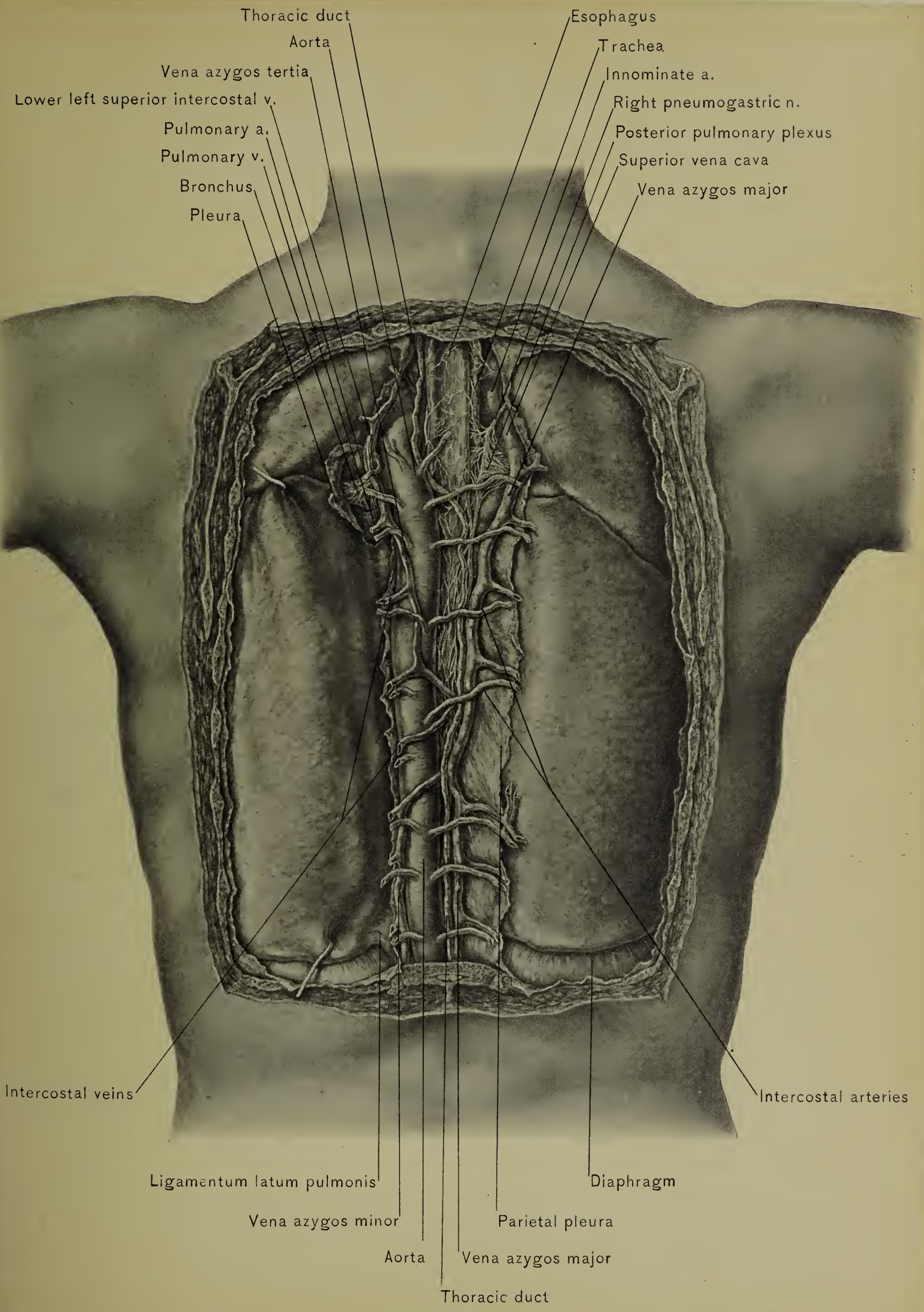
The **left pulmonary artery** passes directly outward in front of the descending thoracic aorta and the left bronchus to the root of the left lung, where it divides into an upper and a lower branch for distribution to the upper and lower lobes of the left lung. The left pulmonary artery is in relation, below and behind, with the left bronchus, on account of the more vertical course of the latter. The pulmonary veins lie below and in front of it, and it is crossed in front by the phrenic nerve and the left anterior pulmonary plexus, and behind by the thoracic aorta, the left pneumogastric nerve, and the posterior pulmonary plexus.

The dissector will observe, at this stage of the work, the cartilaginous rings of the trachea above the aortic arch, between the innominate and left common carotid arteries; and under and behind the left pulmonary artery he will observe the left bronchus, the right being hidden by the ascending aorta and the adjoining vena cava.

The **Trachea** descends from the neck, in front of the esophagus, to the level of the fourth or fifth thoracic vertebra, where it divides into the two bronchi. This point about corresponds to the lower margin of the manubrium, in front; therefore the lower portion of the trachea will be seen to occupy the superior mediastinum. In front of it lie, in the thorax, the manubrium and the origins of the sterno-hyoid and sterno-thyroid muscles, the remains of the thymus gland, the deep cervical fascia, the transverse aorta (which crosses the trachea just above its bifurcation), the innominate and left common carotid arteries, which are crossed by the left innominate vein, and the deep cardiac plexus. Upon its right side are the innominate artery, the vagus nerve, and the pleura; while upon its left are the left common carotid artery and the pleura, the left vagus, the left recurrent laryngeal nerve, and the cardiac nerves. Its cervical portion has been described with the neck, likewise the tracheotomy operations.

STRUCTURE.—The trachea is a cartilagino-membranous tube, plano-cylindrical on cross-section, and composed of incomplete cartilaginous rings, deficient posteriorly; a fibro-elastic membrane enveloping and uniting these rings; muscular fibers; a layer of yellow elastic fibers; and, as an internal lining, mucous membrane.

The rings vary in number from sixteen to twenty. Two cartilages are occasionally partly united. Of these, seven or eight are found in the trachea above the upper opening of the thorax, and the remainder are found in the thoracic portion. The first ring may fuse with the cricoid cartilage, and is usually broad. The last ring at the bifurcation of the trachea has a somewhat Y-shaped appearance in



POSTERIOR MEDIASTINUM, VIEW OF TRACHEA, BRONCHI, LUNGS, AND HEART FROM BEHIND.

front, a process extending downward and backward from the middle of the cartilage. The trachealis muscle consists of two layers of unstriated muscle, and is found posteriorly where the cartilages are deficient. The fibro-elastic membrane envelops the rings and binds them together; it also helps to close the trachea where the rings are deficient. Yellow elastic fibers are found as a layer in the posterior part of the trachea, but are also observed throughout the mucous membrane. The mucous membrane is lined with ciliated columnar epithelium and contains numerous glands in the part lining the posterior portion of the trachea.

BLOOD SUPPLY.—The tracheal arteries are usually derived from the inferior thyroid artery.

NERVE SUPPLY.—The trachea is supplied by the pneumogastric and inferior laryngeal nerves and by filaments of the sympathetic nerve.

The **Bronchi** are the two branches of the trachea at its bifurcation. They occupy the middle mediastinum, being component parts of the roots of the lungs, but are described here for convenience. The differences between the two bronchi may be summed up as follows: The right bronchus is about one inch (2.5 centimeters) long, is shorter and more horizontal than the left, and has a larger caliber; the left bronchus is about two inches (five centimeters) long, and is longer, narrower, and more vertical than the right. The two bronchi diverge at an angle of about 130 degrees. The right bronchus has arching over it from behind, the vena azygos major on its way to the vena cava, while the horizontal right pulmonary artery lies at first below, and then anterior to, the bronchus; below the first division of the right bronchus the pulmonary artery lies posterior to the bronchus. The left bronchus crosses in front of the esophagus, thoracic duct, and descending aorta, under the transverse aorta, and lies behind the left pulmonary artery. The orifice of the right bronchus being larger than that of the left and placed nearly under the center of the trachea, foreign bodies most usually enter the right bronchus.

In certain cases of aneurysm of the transverse and beginning of the descending aorta the pulsation of the aneurysmal sac leads to depression of the left bronchus, with consequent downward movement of the trachea. If in such cases the larynx be lightly grasped between the thumb and finger, this traction upon the wind-pipe, synchronous with the systole of the heart, is felt. This sign is known as the “tracheal tug.”

Foreign bodies entering the air-passages may lodge in the larynx, in the trachea, or may enter one of the bronchi, usually the right one. Foreign bodies have been removed from the right bronchus through an opening made in the trachea in the neck. In this way MacCormac removed from the bronchus the blade of a tooth forceps (Treves). Foreign bodies in either bronchus can also be

removed by resecting portions of several ribs (usually the third, fourth, and fifth) near their vertebral extremity. The pleura should be avoided in this procedure and gradually, by blunt dissection, it should be separated from the chest-wall till the bronchus is exposed. Several intercostal arteries will require ligatures. This procedure is termed **bronchotomy**.

The **Esophagus**, or **Gullet**, is a muscular tube, beginning at the level of the sixth cervical vertebra opposite the lower border of the cricoid cartilage, and is the portion of the alimentary canal connecting the pharynx with the stomach. It consists of a cervical and a thoracic portion. The cervical portion has been described with the neck. The thoracic portion is the continuation downward of the esophagus behind the trachea and in front of the spinal column, through the superior and posterior mediastinal spaces. The esophagus follows the curves of the cervical and dorsal spine, till it passes in front of and to the left of the aorta just before penetrating the diaphragm to empty into the stomach. Besides the deviation to the left at the diaphragm it shows a lateral curvature, also to the left, at the root of the neck. Its caliber is narrowed in three localities: one is at the beginning, opposite the cricoid cartilage; another two and three-fourths inches (6.9 centimeters) below that point; and one at the point where it passes through the diaphragm. Dr. Moulton found the caliber at those points to be a little over one-half inch (1.25 centimeters) in diameter. Elsewhere it is about three-fourths of an inch (1.9 centimeters). The constrictions at these points are apt to intercept bodies that are too large; they also show the effects of swallowed corrosive substances more definitely. Stricture of the esophagus may result from contracting scars following ulceration. The operation of esophagotomy for the removal of foreign bodies has been described with the neck.

Foreign bodies impacted in the esophagus are very apt to lead to ulceration that may open into the adjacent parts, such as the aorta, the trachea, and the vena azygos major. Carcinoma of the esophagus, when it spreads, is also apt to invade the adjacent parts, especially the trachea or bronchi. When it spreads to the pleura, the right is the one it usually invades, since it is in more intimate relation with the esophagus. Cancer of the esophagus can so spread as to invade the thyroid body, the pericardium, and the lung, and has opened up the first intercostal artery in one case and the right subclavian in another (Butlin's "Sarcoma and Carcinoma," 1882). The operations performed upon the esophagus have been described under the dissection of the neck.

If cancer or ulcerative disease affect either the left bronchus or the esophagus at the intersection, a communicating opening may form between the two and a septic pneumonia be caused by the passage of food into the lung.

RELATIONS.—In the neck, the esophagus is in relation, in front, with

the trachea, the posterior part of the left lateral lobe of the thyroid gland, and the left recurrent laryngeal nerve. Behind, it rests upon the vertebral column and the left longus colli muscle. On its left side are the common carotid and subclavian arteries, the inferior thyroid artery, and the thoracic duct. On its right side are the right common carotid artery and the right recurrent laryngeal nerve.

In the thorax the esophagus has in front of it, in the superior mediastinum, the trachea, the beginning of the left bronchus, the transverse aorta, and the left common carotid and subclavian arteries. In the posterior mediastinum it has in front of it the posterior surface of the pericardium. Behind, it comes in relation with the vertebral column, the left longus colli muscle, and the thoracic duct in the superior mediastinum; and with the vertebral column, the thoracic duct, the vertebral portion of the right aortic intercostal arteries, the vena azygos minor, and the lower part of the thoracic aorta in the posterior mediastinum. Laterally it comes in relation in the superior and posterior mediastinal spaces with the pleura and the pneumogastric nerves, which latter form a plexus surrounding the esophagus in the posterior mediastinum, called *plexus gulæ*. The aorta is to the left, and the vena azygos major to the right of the esophagus, and the left pneumogastric nerve passes down in front of and the right pneumogastric nerve behind, the esophagus to the stomach.

STRUCTURE.—The wall of the esophagus is composed of three coats—muscular, submucous, and mucous. The muscular coat consists of voluntary muscular fibers in the upper one-third or one-half of its extent, arranged in a longitudinal and a circular manner, and is rather thick. The submucous coat contains many racemose glands and serves to connect the muscular and mucous coats. The mucous coat presents deep longitudinal folds, and is lined with stratified squamous epithelium.

BLOOD SUPPLY.—The blood supply of the esophagus is derived from the inferior thyroid, the aorta, and branches of the gastric and phrenic arteries.

NERVE SUPPLY.—The nerve supply of the esophagus is derived, mainly, from the pneumogastric nerves, through the plexus gulæ.

The *lymphatic glands* of the superior mediastinum, also called cardiac glands, are found in front of the arch of the aorta, lying on the upper part of the pericardium. They receive the lymphatics from the upper and anterior part of the pericardium and from the right side of the heart, from the thymus gland, and from the anterior mediastinal glands. Their efferent vessels run upward on either side of the trachea and empty into the right lymphatic duct and the thoracic duct respectively.

The **Thoracic Duct** can be described as consisting of three parts—abdominal,

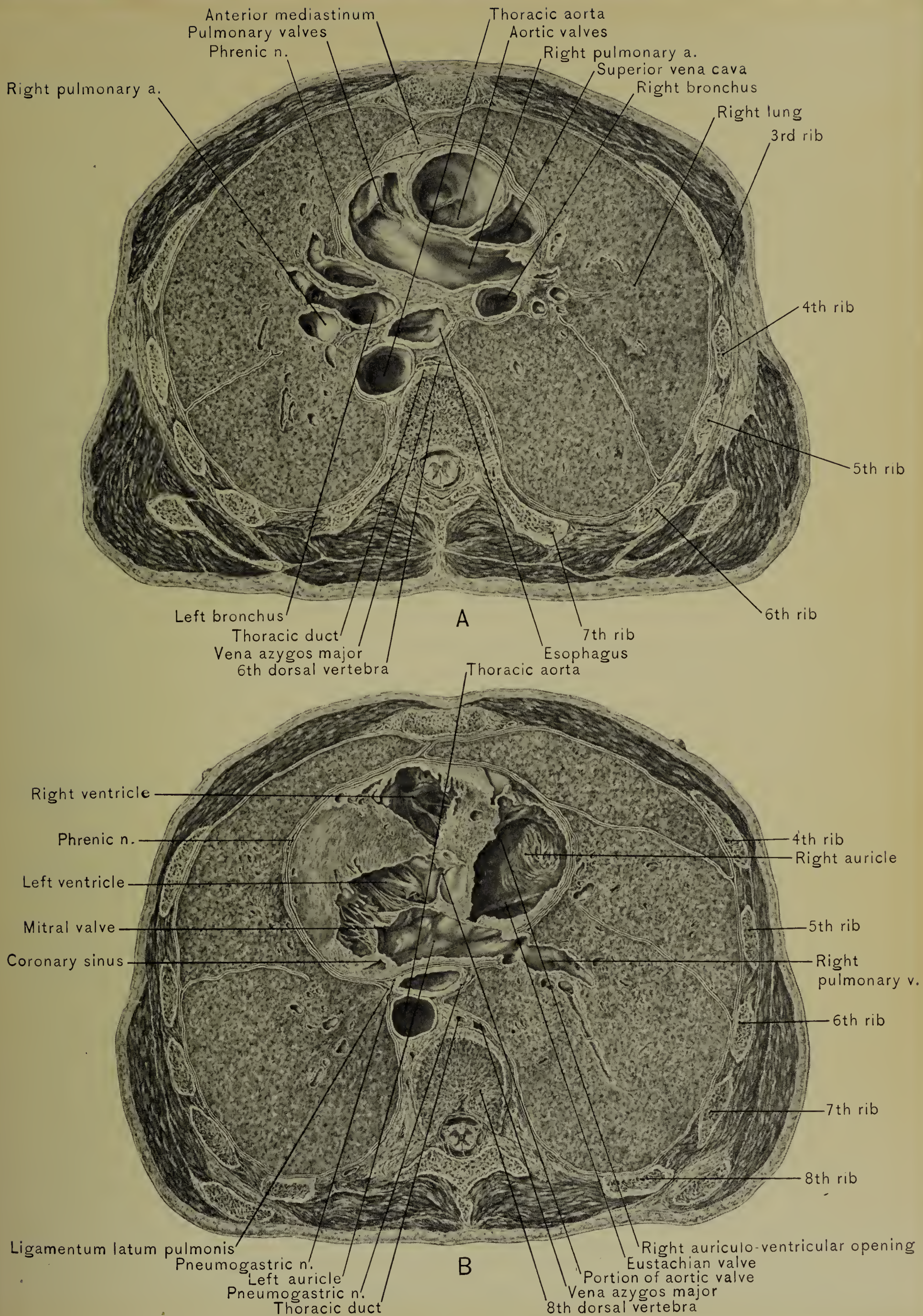
thoracic, and cervical. It occupies the superior mediastinum in part of its course. It begins at the receptaculum chyli at the level of the second lumbar vertebra, enters the thorax through the aortic opening in the diaphragm, and runs upward behind the esophagus and to the right side of the aorta in the posterior mediastinum. It then passes through the superior mediastinum and leaves the thorax by passing through its upper opening to enter the neck. It empties at the junction of the left subclavian and internal jugular veins. It will be more fully described with the posterior mediastinal space.

THE MIDDLE MEDIASTINUM.

The **Pericardium** is the fibro-serous investiture of the heart, enabling this most active organ to glide freely and quickly within its limited area without needless friction. Its form is better understood from the demonstration afforded by its inflation with a blow-pipe than from any description. With this sac in a distended condition before him, the dissector will observe that it is narrow above at its attachment to the great vessels, and broad below where it adheres to the central tendon and left leaflet of the diaphragm, being therefore conical in outline, with its apex above and its base below, the latter extending more to the left side. Vertically the pericardium reaches from the xiphoid appendix to the middle of the manubrium. Opposite the fourth intercostal spaces it reaches two and one-fourth inches (6.1 centimeters) to the right of the median line. It consists of a fibrous and a serous layer.

The **fibrous layer** comprises all the parietal portion of the sac, and is loosely attached everywhere, except at the inferior vena cava. It extends from the base of the heart along the great vessels, including the ascending aorta, the ductus arteriosus, the entire pulmonary artery, the superior vena cava, and the pulmonary veins. Above, over the great vessels, it is continuous with the deep cervical fascia. The sterno-pericardiac ligaments, two slender bands of fibrous tissue, connect the back of the sternum and the front of the pericardium above and below.

The **serous layer**, as all serous layers, is smooth and glistening, being lubricated by a small amount of serous fluid that permits free movement of the heart. It is reflected from the inner surface of the fibrous layer, which it lines as the parietal portion, to the roots of the great vessels and the surface of the heart, constituting there the visceral portion. Between the layers is the cavity of the pericardium, which is closed, as are all serous cavities (except the peritoneal cavity of the female, which is open by way of the Fallopian tubes). The pericardial cavity is about sufficient to hold a fully distended heart and a small quantity of serous fluid. It may, however, be greatly increased so as to hold as much as ten ounces (300 cubic centimeters) without displacing the heart.



CROSS-SECTIONS OF THE THORAX.

(A) THROUGH THE ROOTS OF THE LUNGS. (B) BELOW THE ROOTS OF THE LUNGS.

The serous layer by its reflection forms a number of pouches. One of these, the *oblique sinus*, extends upward behind the left auricle, between the inferior vena cava and the lower left pulmonary vein, to end behind between the pulmonary veins of both sides. It partially lines the pulmonary arteries and the pulmonary veins, whose investment is completed by the smaller pouches derived from the great sac dipping in between the vessels to meet the reflections of the oblique sinus. Pouches are also found between the inferior vena cava and the upper right pulmonary vein, and the left pulmonary artery and the upper left pulmonary vein.

The *vestigial fold of Marshall* is a reduplication of the serous layer of the pericardium between the left pulmonary artery and vein and incloses some areolar tissue and fat, together with a fibrous band, the *ligamentum cavæ sinistræ*, which is continuous above with the left superior intercostal vein and at the heart with the oblique vein of Marshall and the left auricle. It is the obliterated *left duct of Cuvier*, or left superior vena cava.

The inferior vena cava is but partially invested by the serous layer, while the aorta and pulmonary arteries receive complete tubular investments.

RELATIONS.—In front of the pericardium are the thymus gland, or its remains, areolar tissue, lymphatic glands, the sterno-pericardial ligaments, the triangularis sterni muscle, the internal mammary vessels, and the sternum. On the sides are the mediastinal pleura, the lungs, and the phrenic nerves and vessels between the mediastinal pleura and the side of the pericardium. Behind, it lies on the bronchi, esophagus, pneumogastric nerves, deep cardiac and pulmonary plexuses, and the descending aorta.

BLOOD SUPPLY.—The blood supply of the pericardium is derived from the aorta, and the bronchial, esophageal, phrenic, internal mammary, and musculo-phrenic arteries.

NERVE SUPPLY.—The nerve supply of the pericardium is derived from the phrenic, sympathetic, and right vagus nerves.

The *lymphatics* of the pericardium empty into the anterior, superior, and posterior mediastinal glands and the bronchial glands.

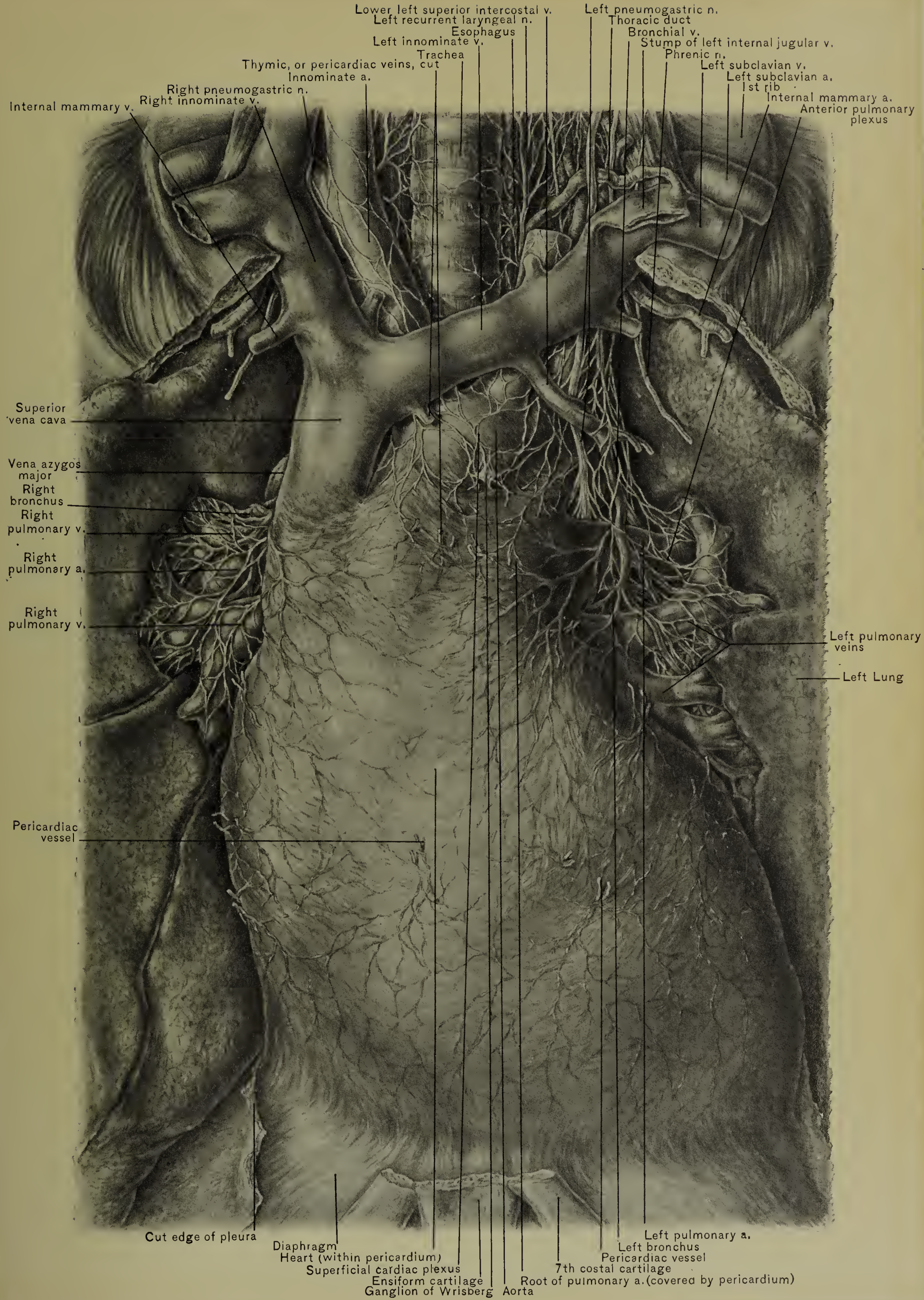
Pericarditis is an inflammation of the pericardium, and pursues the usual course of serous inflammations; that is, the inflammation may result in an exudate of serum, fibrin, or pus. At first the membrane becomes swollen from vascular turgescence and the surface becomes dry. In consequence of this the rubbing together of the surfaces of the parietal and visceral layers is distinctly heard through the chest-wall and is synchronous with the beat of the heart. Adhesions may form in the fibrinous variety of exudate, but the intense activity of the heart repeatedly tears them apart, thus giving a ragged, shaggy appearance to the internal surface of the serous layer of the pericardium. On the other hand, the layers

may unite in places around the great vessels and base of the heart, where there is less motion, and thence the union may gradually extend downward and fix the entire heart to its enveloping sac, each successive encroachment from above upon the heart's freedom of movement making it more possible for the union to extend toward the apex. In the serous form of exudate the effusion may be abundant, so as to distend the pericardial sac. In acute cases the pericardium may contain as much as from twelve to eighteen ounces (360 to 540 centimeters) of serum, and in chronic cases it may reach three pints (1.5 liters). The symptoms due to pressure from these large accumulations vary with the position of the patient, which determines the direction of pressure. In the dorsal decubitus the pressure is upon the esophagus, and may cause dysphagia. Upward pressure upon the right auricle and vena cava, as well as the compression of the heart itself, may cause venous turgescence of the face and neck, and possibly edema. It also causes forward projection of the sternum, or bulging of the interspaces, and, of course, displacement of the lungs, especially the left one, this being especially marked in children. In the last instance the area of cardiac dullness is increased, the heart sounds are muffled, and the apex-beat is no longer perceptible. In patients suffering from the purulent form of exudate the sac has been opened and irrigated with antiseptic solutions through one of the interchondral spaces, or the left xipho-costal angle; portions of the costal cartilages or sternum have been removed when required and a drainage-tube inserted.

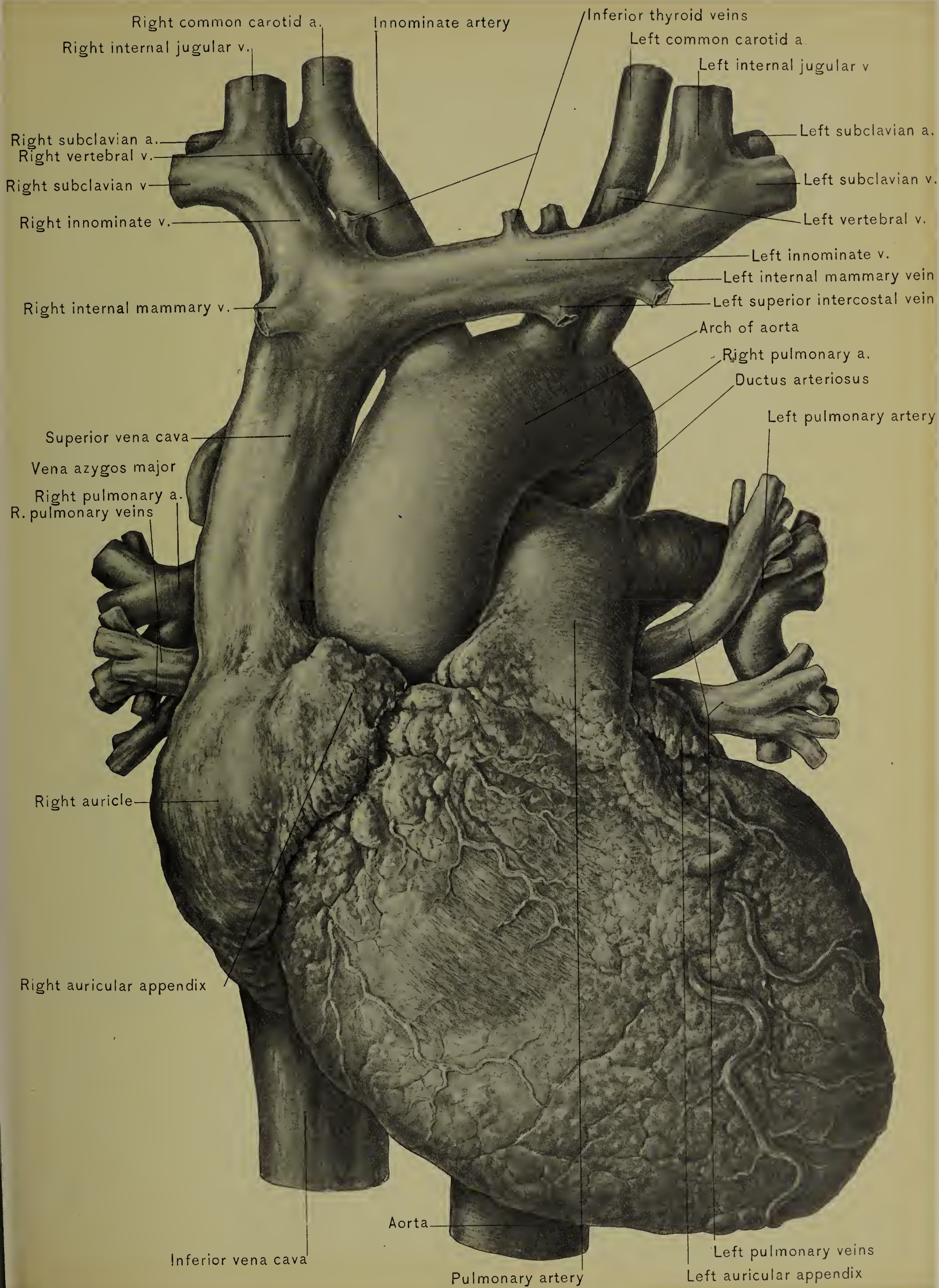
Paracentesis of the pericardium may become necessary when the fluid is not absorbed. This may be done through the fourth left intercostal space close to the sternum, avoiding the internal mammary artery; or through the fourth interspace one inch (2.5 centimeters) from the left sternal border; or through the fifth interspace one and a half inches (3.8 centimeters) from the left border of the sternum; or through the left xipho-costal angle. This has been mentioned under surface anatomy of the thorax.

Pericarditis may cause *reflex cough* through irritation of the phrenic nerves, and through venous engorgement of the lungs due to interference with the pulmonary circulation caused by cardiac compression.

DISSECTION.—The pericardium is to be opened by a vertical incision extending from its apex to its base, and the two parts reflected, when there will be exposed the following objects: Parts of the right and left ventricles, and between them the interventricular sulcus, the right auricle with its appendix overlapping the root of the aorta; the appendix of the right auricle overlapping the root of the pulmonary artery, the auriculo-ventricular sulcus; the pulmonary artery, covering the root of the aorta; the ascending aorta, the superior vena cava, and the right and left coronary arteries. By raising the heart it will be found that the greater



PERICARDIUM AND ROOTS OF THE LUNGS.



ANTERIOR VIEW OF THE HEART AND ITS VESSELS.

part of the left ventricle lies posteriorly, together with a small portion of the right ventricle. Above the ventricles posteriorly will be seen the coronary sinus, running in the auriculo-ventricular groove. Into it can be seen emptying the cardiac veins and the oblique vein of Marshall. The roots of the pulmonary veins and the inferior vena cava above the diaphragm can also be observed behind.

The **Heart** is a hollow muscular organ of pyramidal shape with its apex directed downward, forward, and to the left, beating against the fifth intercostal space about one inch to the inner side of the left nipple line. It is about the size of the closed fist of its possessor. It rests upon the central tendon and part of the left leaflet of the diaphragm and is behind the lower two-thirds of the sternum. It is suspended from the neck by the aorta and the three great branches of its transverse portion, and by the downward prolongation upon the aorta and pulmonary artery of the deep cervical fascia, which blends with the pericardium; and it is also supported from the roots of the lungs by the pulmonary arteries and veins. The direction of its base is the opposite of that of the apex—*i. e.*, upward, backward, and to the right; the base occupies the same level as the middle four thoracic vertebræ, largely filling the space between them and the sternum. Its position is considerably changed by disease of neighboring organs. Thus, pleural effusions will crowd it to one side, as will also collapse or retraction of a lung, or lateral curvatures of the spine that narrow one of the pleural spaces. It is pressed downward by tumors of the superior mediastinum and drawn downward by marked diminution in size of the adjacent abdominal viscera. Abdominal dropsy or tumors will push it upward.

The front of the heart, as seen when the pericardium is opened, is composed mainly of the right ventricle below, and the right auricle above, only a narrow strip of the anterior edge of the left ventricle being visible upon the left side. The right and lower margin, formed by the right ventricle, is sharp and thin, and is therefore called *margo acutus*; that to the left and above, formed by the much thicker left ventricle, is full and round, and consequently designated *margo obtusus*.

The heart should be raised from its bed so that the fingers may pass behind it and note the height to which the pericardium extends up the back of the great vessels. The shape of the back of the sac should be noted. Backward pressure of the finger will reveal the bodies of the thoracic vertebræ. Lateral pressure will reveal the resistance of the lungs, especially if they be inflated. If the segment of the sternum and its attached cartilages be replaced, the topography of the heart may be profitably considered; but as this organ is collapsed, it should be inflated. This may be done by rapid puffs through the superior vena cava, which will distend the right side and the pulmonary artery. If the arterial injection has

not ruptured the aortic valves and filled the left side, this portion may be inflated through one of the pulmonary veins. While the heart is thus kept in distention by one or two persons making a succession of sharp sudden puffs through suitably long and curved blow-pipes, another can indicate its superficial relations. This practice is too valuable to neglect.

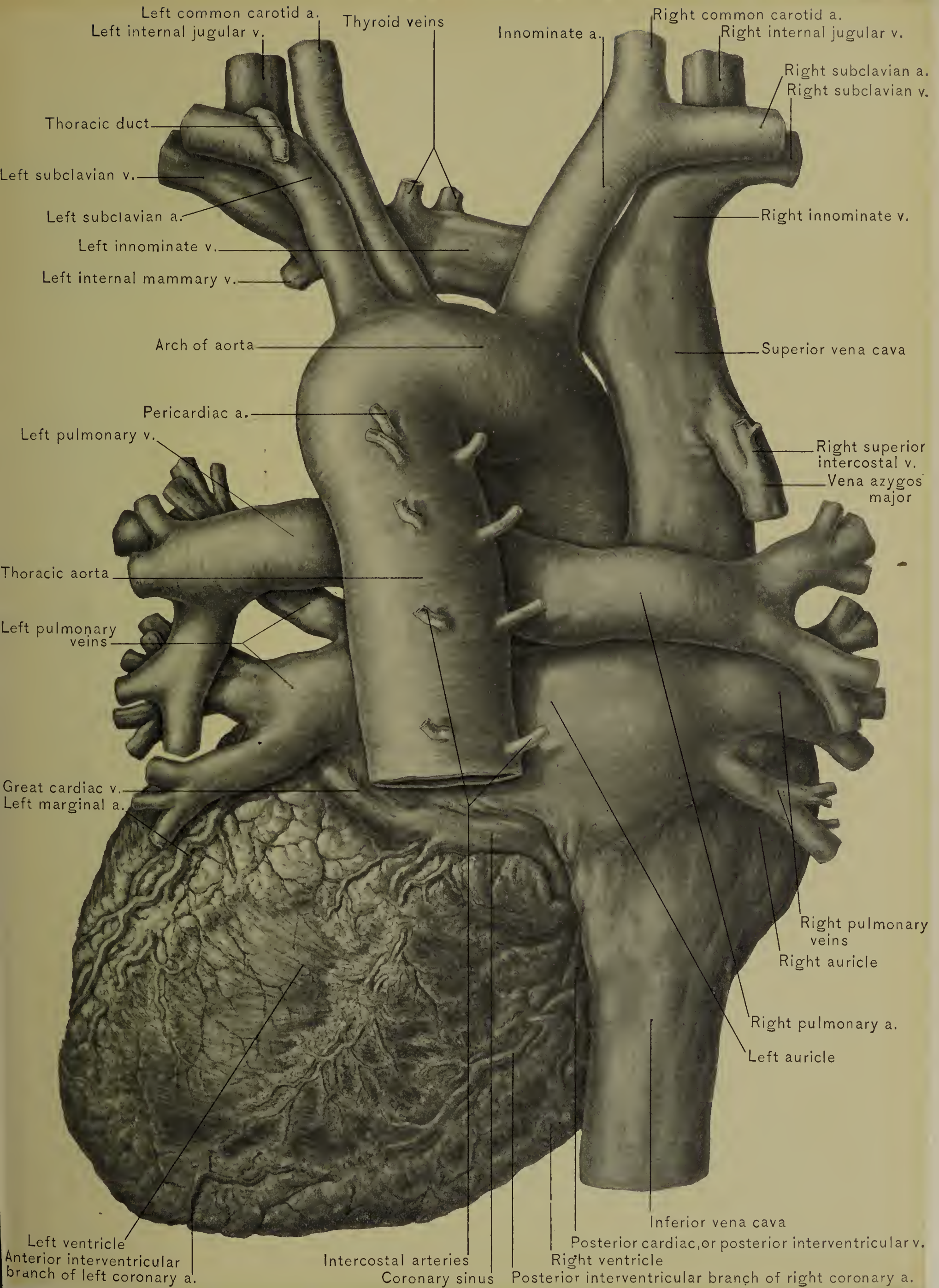
The detailed anatomy of the heart is not well shown in a dissecting-room specimen, but this must suffice if no other be at hand. Should another heart be available, it is well to open the attached specimen so as to show the valves *in situ*, that they may be compared with the anterior surface of the chest. A fresh bullock's heart serves admirably for demonstration.

The heart has four chambers: two right and two left, or two upper and two lower. The upper, smaller, and weaker are the **auricles**, so called because of their ear shape; and the lower and stronger are called the **ventricles**. The auricles receive blood for transmission to the ventricles, which then force it onward. The right side of the heart forces the blood through the lungs for oxidation and the left side impels it through the body at large for nutrient purposes. The septa between these cavities are indicated by furrows. The right auricle and the right ventricle constitute the venous side, while the left auricle and ventricle constitute the arterial side of the heart.

The furrows are called **interventricular** and **auriculo-ventricular**, the former either anterior or posterior and the latter either right or left, the designation being amply expressive of their location. They lodge branches of the coronary arteries.

The **right coronary artery** passes at first forward between the pulmonary artery and the right auricular appendix and then downward and outward along the right auriculo-ventricular groove to the posterior surface of the heart, where it gives off a descending branch, the **interventricular**, that passes along the posterior interventricular groove to anastomose at the apex with a similar branch from the left coronary in front. The right coronary continues into the posterior part of the left auriculo-ventricular groove to anastomose with a similar branch of the left coronary artery. On its way it sends a branch along the margin of the right ventricle, called the **marginal branch**. It also gives off branches to the right auricle (auricular) and a **preventricular branch** to the front of the right ventricle, as well as branches to the roots of the aorta and to the pulmonary artery. It supplies both ventricles and the right auricle, as well as the posterior interventricular septum.

The **left coronary artery**, the smaller, emerges from between the left auricular appendix and the pulmonary artery to enter the front of the left auriculo-ventricular groove, where it divides into two branches, one passing down the anterior interventricular groove (**interventricular**) to anastomose at the apex with the correspond-



POSTERIOR VIEW OF THE HEART AND ITS VESSELS.

ing posterior branch, the other passing around the left auriculo-ventricular groove to the back of the heart, there to anastomose with the like branch of the right coronary artery. It gives off branches to supply the left auricle (auricular); a marginal branch along the left margin of the heart, and a smaller branch to the left auricle, both ventricles, and the roots of the aorta and pulmonary artery.

Disease of the walls of the coronary arteries (arterio-sclerosis), resulting in occlusion of the lumen of the vessels, causes fatty degeneration of the heart muscle. A symptom of this condition is **angina pectoris**.

The **three large veins of the heart** are the great, the anterior, and the posterior cardiac; they accompany the coronary arteries and return the blood from the walls of the heart.

The **great cardiac vein** begins at the apex and passes up the anterior inter-ventricular furrow to the base, when it curves to the left, along the left auriculo-ventricular groove to the back of the right auricle, where it empties into the coronary sinus. Numerous veins from the ventricles and auricles empty into it.

The **posterior cardiac** or **posterior interventricular vein** ascends in the posterior interventricular groove from the apex to the base, receiving the veins from the back of both ventricles, to empty into the coronary sinus, where it is supplied with a valve. Several small **anterior cardiac veins** collect the blood from the front of the right ventricle and empty into the front of the right auricle. The largest of these runs along the right margin of the heart, and is called the **vein of Galen**.

The **coronary sinus** is the continuation of the great cardiac vein, greatly increased in caliber. It is about one inch (2.5 centimeters) long and runs along the posterior surface of the heart in the auriculo-ventricular groove and empties into the right auricle, where its orifice is guarded by the Thebesian valve. From the vestigial fold of the pericardium the oblique vein of Marshall may be traced along the posterior wall of the left auricle to its termination in the coronary sinus. It is rarely pervious and represents the obliterated portion of the fetal left duct of Cuvier (left superior vena cava).

The **coronary plexuses**, derived from the cardiac plexuses, have been described; they accompany the coronary artery. Many ganglia can be observed near the auriculo-ventricular groove under the pericardium.

Considerable fat often invests the heart, especially at the base, even in lean individuals, though this is wanting in those who die of wasting diseases. The coronary arteries are generally embedded in fat at their origin and for some distance beyond. If the entire heart be covered with a distinct layer of fat, the condition is abnormal.

The average weight of the heart is about ten to twelve ounces (300 to 360

grams) in males and about two ounces (60 grams) less in females. The average capacity of its chambers is two ounces (60 cubic centimeters) each, though they are not all filled simultaneously in the living state, as will appear in studying its circulation.

DISSECTION.—Remove the heart by cutting the vessels as far away from it as possible, care being taken to leave the bronchi intact. The interior of the heart is best studied by opening its cavities in the order in which the blood flows through them. The accompanying instructions as to the time and manner of opening these should be strictly adhered to. A rubber tube containing water under several pounds' pressure should be at hand to demonstrate the action of the valves, as the blow-pipe seldom suffices for this purpose.

The **right auricle** is thin, its walls being only about a line in thickness, and is composed of an appendix auriculæ, overlapping the origin of the aorta, and the main portion, called the sinus of the auricle.

It should be opened by an incision extending between the openings of the two venæ cavæ, and another from the middle of this to the tip of the appendix. Its interior should then be gently cleansed of its dark blood, when the following points are to be observed :

The **openings of the right auricle** are :

(A) The *superior vena cava*, in the upper anterior part, bringing blood from the head, neck, upper extremities, and upper part of the thorax, the direction of the current being toward the ventricular opening.

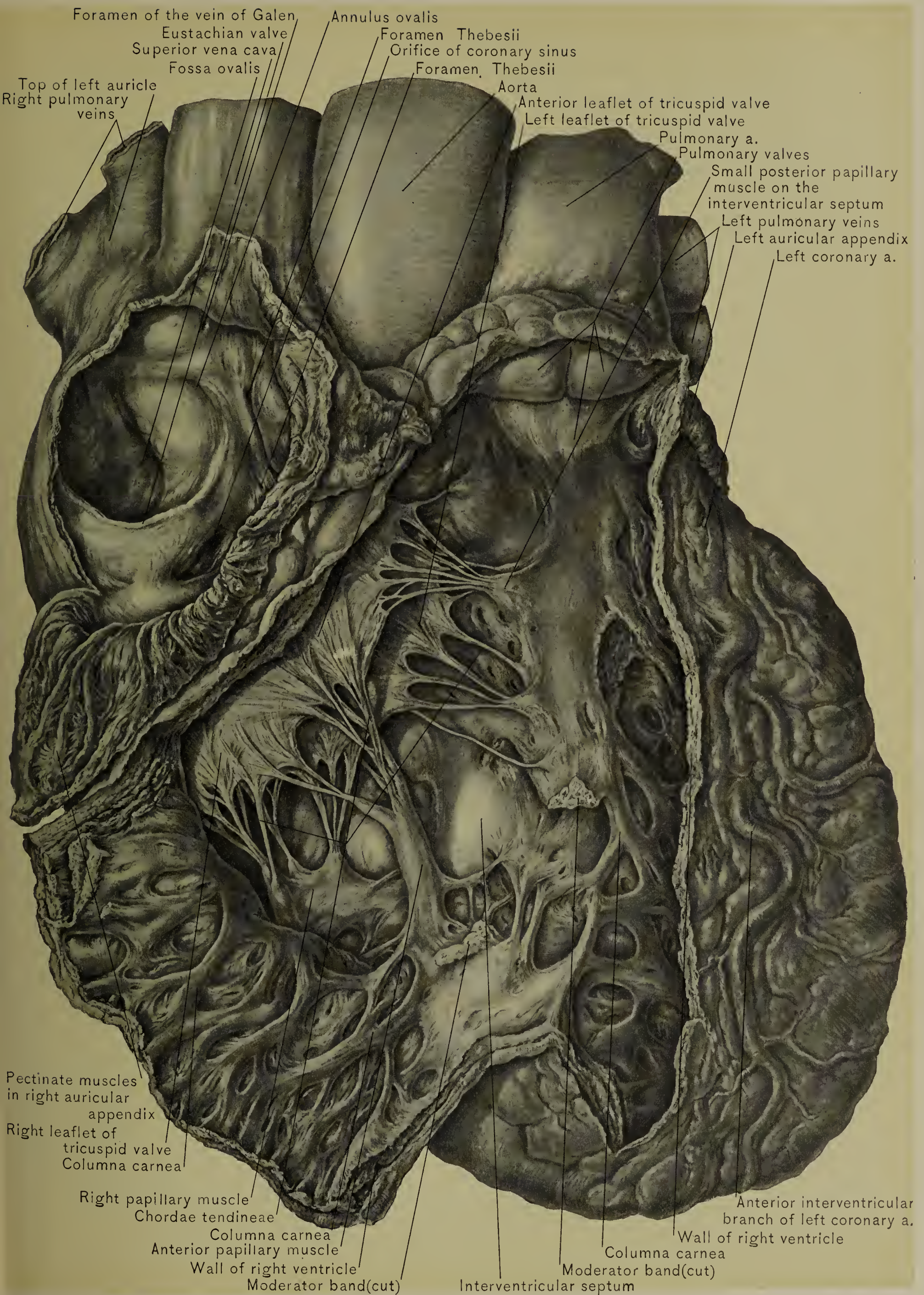
(B) The *inferior vena cava*, the larger cava, directed upward and inward at the lower part of the auricle, where it hugs the diaphragm, the direction of the current being toward the auricular septum.

(C) The *orifice of the coronary sinus* is situated between the preceding two and a little toward the ventricular opening. From it flows most of the venous blood collected from the heart substance by the cardiac veins. At its orifice is a fold of the lining membrane of the heart, the endocardium, which is called the coronary valve, or valve of Thebesius. The sinus is dilated back of its opening, but is constricted at its junction with the great coronary vein, where two unequal valvular segments prevent regurgitation.

(D) The *foramina Thebesii* are numerous minute openings of small veins, called venæ cordis minimæ, or Thebesii, to be seen in different portions of the inner surface of the auricle ; sometimes they are but the openings of small cecal ducts. The right marginal vein is quite constant, and opens below the superior vena cava on the septal wall. It is also called the vein of Galen.

(E) The *right auriculo-ventricular orifice* will be described further on.

The **Eustachian valve** is a crescentic fold of endocardium, containing a few



RIGHT AURICLE AND VENTRICLE.

muscular fibers, situated between the openings of the inferior vena cava and the right ventricle. It is attached to the former by the convex margin, its free concave edge is attached by one end to the anterior edge of the annulus ovalis, and the right blends with the auricular wall. It is a remnant of fetal life, when its duty was to direct the blood from the lower vena cava to the left auricle. It is not always present in adult hearts.

The **interauricular septum**, or **septum atriorum**, forms the posterior wall of the auricle. Upon this, a little above the opening of the inferior vena cava, is an oval depression, called the **fossa ovalis**, with a very thin floor, that marks the site of the foramen ovale of the fetal heart. Its surrounding ridge, the **annulus ovalis** (*limbus fossæ ovalis*), is incomplete below. The original foramen ovale is an oblique slit in the septum atriorum, the walls of which are approximated by the blood pressure from both sides, upon the birth of the child, and thus they become agglutinated. When this closure is incomplete, there is a mingling of arterial and venous blood, and the face and lips become blue, giving rise to the term “a blue baby.” It is at times open, or “patulous,” in the adult, but closed by the bilateral pressure upon its wall, thus preventing the mingling of the contents of the two auricles.

The **tubercle of Lower** is a structure but little marked in man, but quite prominent in some of the lower animals. It occupies a position to the right of the cavity between the two caval orifices.

The **appendix auriculæ** is a small, pointed prolongation of the auricle forward and to the left, in front of the origin of the aorta; its margins are scalloped. In its interior are found muscular columns, which, because of their supposed resemblance to some form of a comb, have been called **musculi pectinati**.

DISSECTION.—The anterior wall of the right ventricle should now be incised for about one inch, about a half inch from the middle of the interventricular furrow. Into this should be inserted a rubber tube of considerable caliber and water under several pounds' pressure should be allowed to flow into the ventricle. The ventricular incision should be held closed around it, and the heart tilted so that the right auriculo-ventricular orifice can be distinctly seen from the auricle, when the water should be permitted to flow suddenly. The valve will be seen to close against the stream, which will be compelled to flow into the pulmonary artery instead of into the auricle. After the completion of the demonstration, extend the ventricular incision to within half an inch of the auriculo-ventricular groove, thence parallel with the groove to the right border of the heart, and then continue the original incision downward to the apex. In cutting across, above, insert the finger into the ventricle from the auricle so as to guard against incising the valve at this opening. The angle of the V-shaped flap thus formed lies near the base of

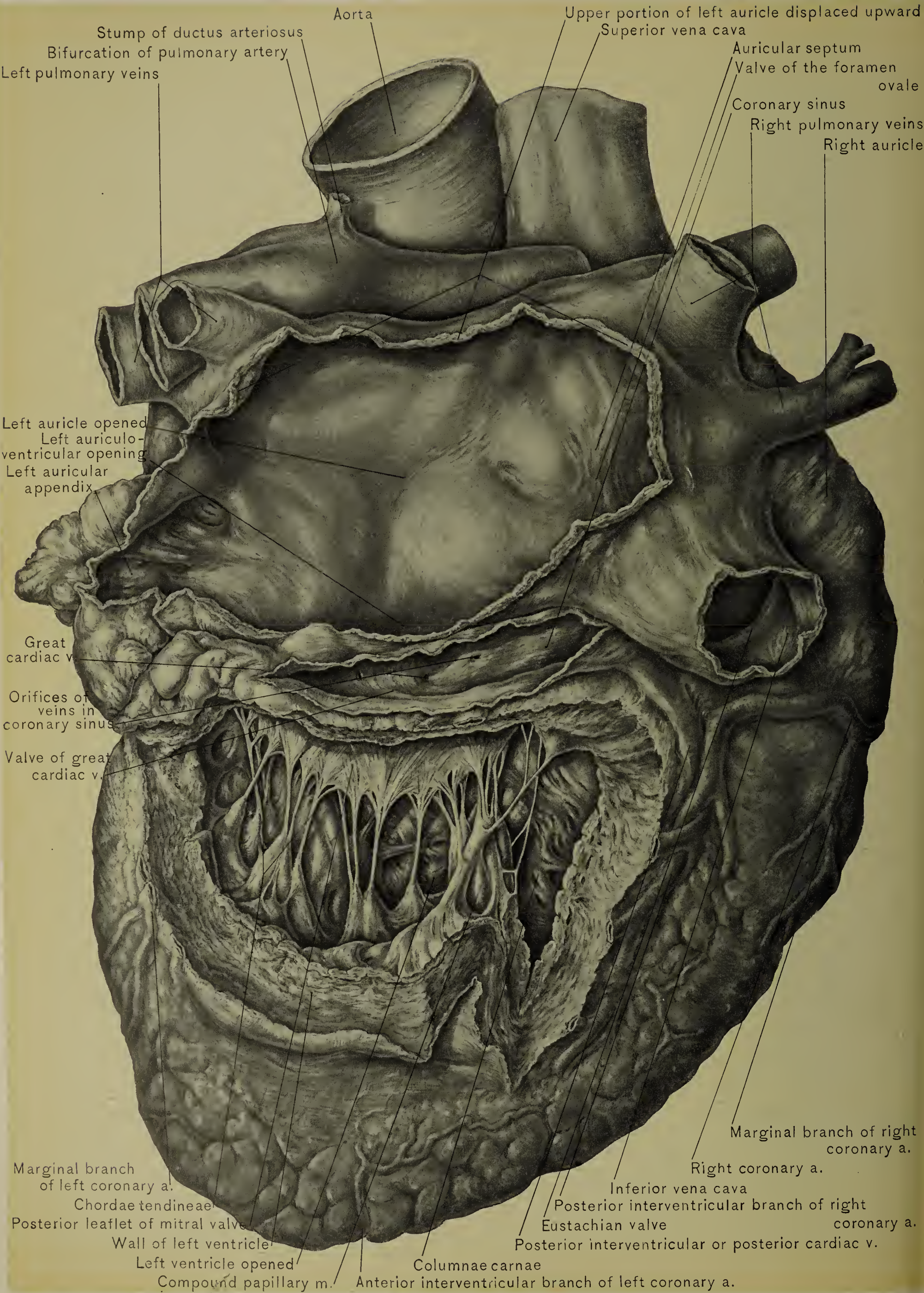
the pulmonary artery; it should be turned downward and outward, revealing the interior of the ventricle, which should be cleaned of any blood that may remain.

The **right ventricle** is triangular in form, its anterior surface is convex, and its diaphragmatic surface is flat. It is conical above toward the origin of the pulmonary artery; this portion is called the **infundibulum**, or **conus arteriosus**. The inner wall of the right ventricle is formed by the septum ventriculorum, which bulges into it. Its wall is thickest at the base and thinnest near the apex, which it does not reach by half an inch or more.

The cavity of the right ventricle is crescentic on cross-section, it being carried around the left ventricle. Its most noticeable features are its **columnæ carneæ**, or fleshy columns, of which there are three varieties: one set forms ridges along the ventricular septum, to which they are attached throughout their entire length; another set is similarly arranged along the walls, but free in the middle and attached only at the ends; and three or four, thicker than the others, are attached to the ventricular walls by one end and have the other extremity rounded and attached to the chordæ tendineæ of the auriculo-ventricular valve; these are called the **musculi papillares**. The **moderator band** is occasionally well marked in man. It is a strong muscular band connecting the anterior wall and the septum ventriculorum.

The **right auriculo-ventricular opening** is situated between the right auricle and ventricle in the median line of the body on a level with the fourth intercostal space. It is more than one inch in diameter and readily admits three average-sized fingers almost up to their middle. Its margin is fibrous and formed by condensed connective tissue, from which project the three cusps of the valve (tricuspid) that guards this opening.

The **tricuspid valve** is composed of three fibro-serous segments attached to the margin of the right auriculo-ventricular opening and partly to one another near their marginal connection with the opening, the remainder of their edges being free except for the attachments of the chordæ tendineæ, some of which are also united to the ventricular surface of these flaps. The cusps, or segments, of this valve are attached, one to the front (marginal cusp), one to the back of the orifice (septal cusp), and the largest and most movable to the left edge between it and the opening of the pulmonary artery (infundibular cusp). Each cusp is thickened in its center and quite thin at its margin. The **chordæ tendineæ** are attached to the cusps of this valve at their central thickenings, and to their free margin, in consequence of which the ventricular portions of the valves are rough, and the auricular smooth. Though very thin, they are also very strong, the thinnest of them quite readily bearing the weight of the entire heart, especially if tested not too long after death. Three smaller cusps are frequently found between the larger leaflets of this valve.



LEFT AURICLE AND VENTRICLE.

The **pulmonary opening** is found at the summit of the infundibulum close to the septum. It lies to the left of the right auriculo-ventricular orifice and in front of the aortic opening, and is opposite the left third costal cartilage near the sternum. It is guarded by the pulmonary semilunar valves, three in number, the middle one being placed anteriorly and a little to the left, the other two posteriorly.

The **pulmonary semilunar valves** should first be subjected to the water test. After completion of the demonstration, the artery should be opened from the ventricle between two of its three valve segments. These are semicircular fibro-serous folds attached to the pulmonary opening like so many wall pockets, their free edges coming together to prevent the backward flow of blood. Each flap is thickest at its margin which contains a small fibrous nodule in its middle, the **corpus Arantii**, from which fibers radiate to the attached base of the flap. When the opening is closed by these flaps, the corpora Arantii come together and fill up what would otherwise be a triangular opening. Behind each valve-flap the artery bulges slightly, forming a sinus (sinus of Valsalva). Near the edge a thin area of crescent shape is seen on each side of the corpus Arantii. These have received the name **lunulæ**, and correspond to the area of contact of the valves.

The **left auricle**, thicker than the right, helps to form the left side and back of the base of the heart, only its auricular appendix being visible anteriorly, upon the left of the pulmonary artery. The appendix is more nodulated and irregular in outline than the right, and is constricted at its junction with the auricle. To open the auricle, incise it from the end of its appendix backward to the posterior auricular wall; then cleanse the auricle. Its inner surface, with the exception of the muscoli pectinati in its appendix, is smooth, and presents the four valveless openings of the pulmonary veins; some small openings of veins, the foramina Thebesii, and the left auriculo-ventricular orifice below. Two of the pulmonary veins open on its left side and two on the right; either or both pairs may unite before their entrance, the left pair doing so more frequently than the right. A slight depression exists in the auricular septum opposite the site of the fossa ovalis in the other auricle.

If the left ventricle be opened as was the right for the corresponding purpose, the action of the bicuspid valve of the left auriculo-ventricular opening can be shown. When this is completed, the ventricle should be opened along the anterior and posterior septal margins and the wall then raised.

The **left ventricle** is longer than the right, its cavity is narrower and more nearly circular in section, it forms the apex, constitutes most of the posterior surface of the heart, and its walls are three times as thick as those of the right ventricle; its walls are thickest near the base and thinnest at the apex, near which

rupture of the heart most often occurs. Its columnæ carneæ are arranged like those of the right side, but are smaller and more numerous, those at the apex being interlaced. There are only two muscoli papillares, one for each of the two cusps of the bicuspid valve.

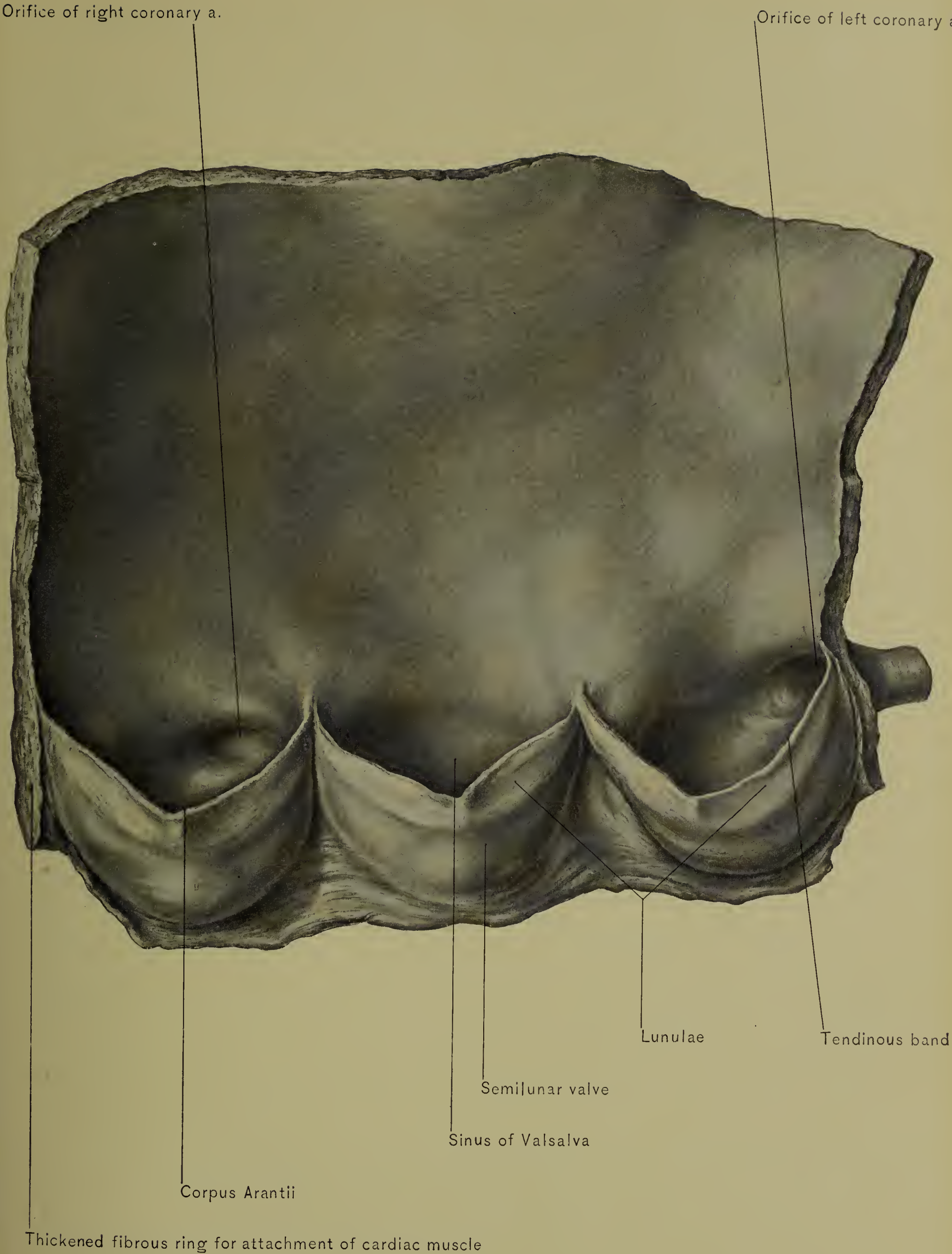
The **left auriculo-ventricular opening** lies to the left of the aortic orifice, and behind, and to the left of, the right auriculo-ventricular opening. Its margin is a fibro-serous ring from which hang the two cusps of its valve. The left auriculo-ventricular opening is smaller than the right, admitting, usually, but two fingers.

The **bicuspid valve**, also commonly called the **mitral valve**, because of its fancied resemblance to a bishop's miter, is composed of two unequal flaps formed like the tricuspid valve, but larger, stronger, and thicker. The larger, anterior cusp is on the aortic side of the opening, corresponding to the location of the tricuspid's largest cusp in relation to the pulmonary artery. The posterior cusp is behind and to the left. Two small segments are generally found at the junction of these cusps. The attachments of the chordæ tendineæ are similar to those of the tricuspid, but the chordæ are fewer, thicker, and stronger. That portion of the ventricular cavity just below the aortic orifices has been called the aortic vestibule (Sibson); its walls are fibrous and do not collapse, thus giving the aortic valves a better opportunity for action.

The **aortic semilunar valves** are usually very well shown in injected dissecting-room subjects, and thus do not require the hydrostatic demonstration, but this should not be omitted if a heart is being studied that has not had its aorta injected. The valves are identical in arrangement with the pulmonary semilunar, except that they are thicker and stronger, the corpora Arantii are larger, the sinuses of Valsalva are more prominent, and two of them are placed anteriorly and one posteriorly, the anterior two giving origin to the coronary arteries.

The **septum ventriculorum** is a muscular partition that is thickest at the apex, growing thinner toward the base, until near the aortic opening, close to its anterior and upper part, where it is devoid of muscular substance and consists of a thin fibro-serous wall, the **pars membranacea septi**. It is situated just below the adjoining ends of the anterior and right posterior flaps of the aortic valve, and forms part of the wall of the aortic vestibule. The pars membranacea is, embryologically, the last portion of the septum to be formed; a defect in this portion of the septum, associated with stenosis of the orifice of the pulmonary artery, is one of the most common congenital abnormalities of the heart.

Injuries of the heart are not uncommonly followed by recovery. Usually it is the right ventricle that is injured, next in frequency the left ventricle, and last



AORTIC SEMILUNAR VALVES.

the left auricle. Wounds of the auricle are more rapidly fatal, owing to the thin walls of those cavities. The ventricular walls, being thicker and more robust, by contracting prevent hemorrhage. The heart can contain foreign bodies for variable lengths of time. Thus, Treves cites cases reported by different observers in which the heart had been transfixed by foils, skewers, and even an iron rod. The latter case lived for one year after the injury. Wounds of the ventricular walls have been successfully sutured.

The **phrenic nerves**, also occupants of the middle mediastinum, have been described with the superior mediastinum. They cross in front of the roots of the lungs and lie between the mediastinal pleura and the pericardial sac, to both of which membranes they distribute branches. They are accompanied by the comes nervi phrenici arteries, and pierce and supply the diaphragm.

The **roots of the lungs**, while occupying the middle mediastinum, will be described, for convenience, with the lungs.

THE FETAL CIRCULATION.

The chief peculiarities of the fetal circulation are the **foramen ovale**, the **ductus arteriosus**, and the **ductus venosus**. They modify the course of the blood current to such an extent that the better quality of blood goes to the head and upper extremities, thus, perhaps, in part at least, accounting for the greater size and development of the upper portion of the body. These peculiarities are best understood by following the blood in its course from the umbilicus through the fetus back to the umbilical cord.

The blood enters the body of the fetus at the umbilicus through the umbilical vein, by which it is conducted in the free edge of the falciform or umbilical ligament to the liver. It gives off branches to the left, spigelian, and quadrate lobes, and then continues to the transverse fissure, to divide into a large and a small branch. The smaller branch joins the left hepatic vein, and then goes to the vena cava as the ductus venosus; the larger division is joined by the portal vein and enters the right lobe of the liver. Thus almost all the blood entering the body of the fetus passes through the liver before entering the heart. A small portion passes into the vena cava directly, some directly into the liver, but most of it mingles with the portal blood before its entrance into the heart.

From the liver all the blood passes into the inferior vena cava, mixing with the blood from the lower extremities, and then to the right auricle, whence it is guided by the Eustachian valve through the foramen ovale into the left auricle. Here it mingles with the little blood returned from the lungs through the pulmonary veins, and then passes into the left ventricle and the aorta. Almost all

of the blood then goes to the head and upper limb, only a very small part descending in the aorta.

The blood returns from the head and upper limbs by way of the superior vena cava to the right auricle, where it is mingled with a slight quantity of the blood from the inferior vena cava. It passes down over the Eustachian valve into the right ventricle, thus crossing the ascending current from the lower cava. From the right ventricle it enters the pulmonary artery, but very little of it passes into the lungs, the main portion going through the ductus arteriosus into the upper end of the descending aorta, by which it is conveyed in part to the lower limbs and pelvis, but mainly through the umbilical arteries to the placenta. The blood from the pelvis and lower limbs collects in the inferior vena cava and meets the incoming fresh stream, as stated at the beginning.

The circulation may be schematically arranged as follows :

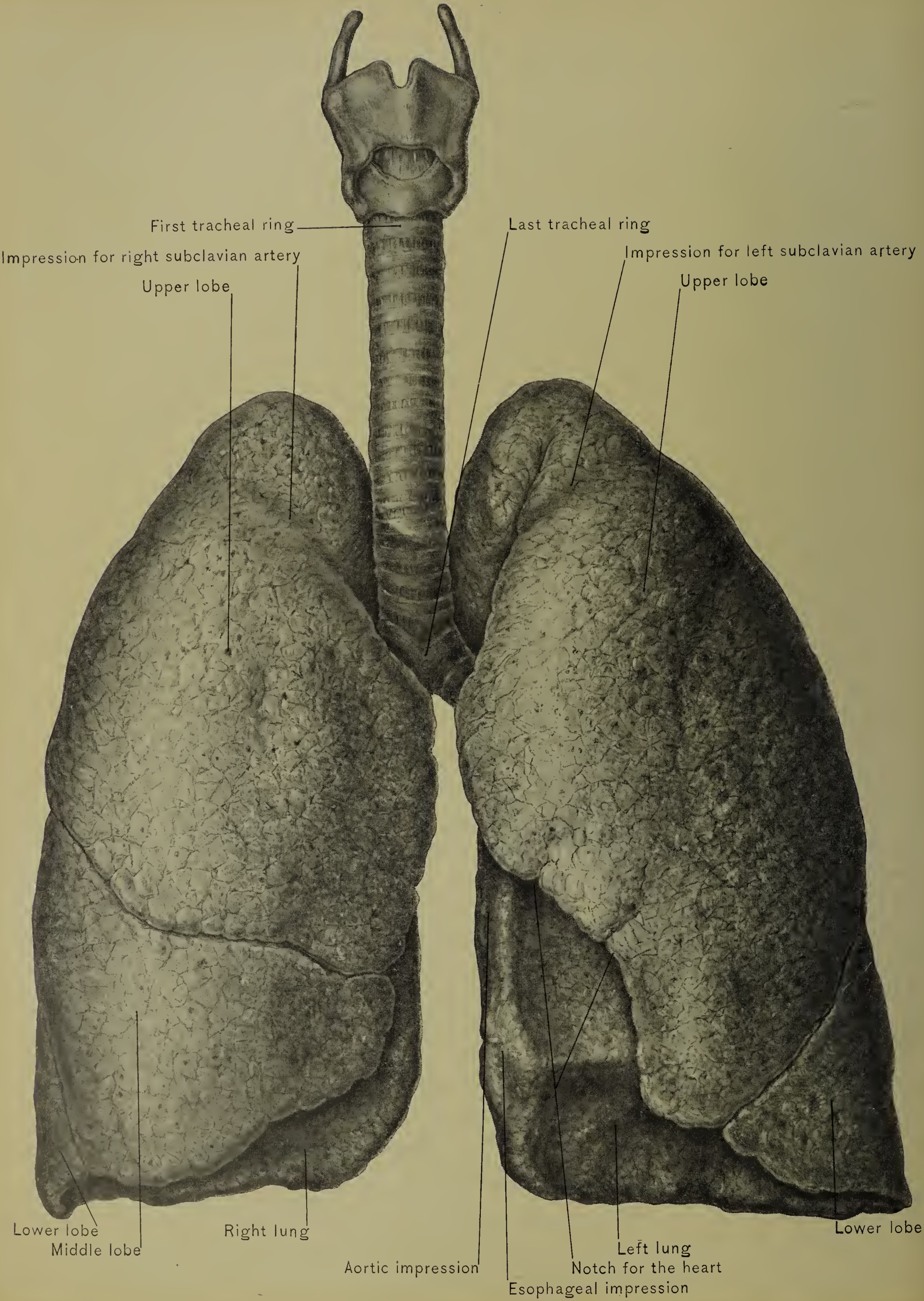
Umbilical vein to the
Liver, and from there by the hepatic veins and the ductus venosus, to the
Inferior vena cava, to the
Right auricle, to the
Left auricle, to the
Left ventricle, to the
Aorta, to the
Head and arms, to the
Superior vena cava, to the
Right auricle, to the
Right ventricle, to the
Pulmonary artery, to the
Ductus arteriosus (very little through the lungs and back to the left auricle
by the pulmonary veins), to the
Descending aorta, to the
Hypogastric arteries, to the umbilical cord (major portion), and to the
pelvis and lower limbs (minor portion), from where it is returned
to the inferior vena cava.

At birth the lungs fill with air and the blood current is diverted from the ductus arteriosus along the branches of the pulmonary artery to the lungs. The duct then contracts, atrophies, and becomes impervious, existing later in life only as a cord connecting the bifurcation of the pulmonary artery with the concavity of the aortic arch.

The umbilical vein and ductus venosus become similarly atrophied, the former becoming the round ligament of the liver.

The hypogastric arteries become the obliterated cords that converge toward the umbilicus from the pelvis upon either side of the urachus, and their intra-pelvic, patulous remains become the superior vesical arteries.

The Eustachian valve stops growing, and is either deficient in adult life or exists merely as a rudiment. The foramen ovale closes in about ten days, though



ANTERIOR VIEW OF TRACHEA AND LUNGS.

Upper lobe

Middle lobe

Upper lobe

Lower lobe

Left lung

Lower lobe

Right lung

POSTERIOR VIEW OF TRACHEA AND LUNGS.

it remains patulous in a large proportion of individuals, rarely causing trouble, however, because of its oblique direction.

THE LUNGS.

The **Lungs** are essentially the respiratory organs, each of the two fitting accurately within its lateral half of the thorax. Between them are the mediastinal spaces, together with their contents, and the bodies of the thoracic vertebræ. Each lung is long and conical, with a tip or apex projecting into the root of the neck, a concave downward and backward sloping base resting upon the diaphragm, an anterior and a posterior border, and an inner, or mesial, and an outer, or lateral, surface. Besides this, the right lung is divided into three lobes, and the left into two.

The **apex** is rounded and projects into the neck for about an inch and a half above the sternal end of the clavicle; it lies behind the anterior scalene muscle and the subclavian artery.

The concave **base** fits accurately upon the convex top of the diaphragm, its thin circumference, much more marked behind, passing into the narrow space between the diaphragm and chest-wall, though not to its bottom, stopping at the tenth rib in the post-scapular line. The lower limits of the lung can be represented by a line drawn around the chest from the junction of the sixth costal cartilage with the sternum to the spinous process of the tenth dorsal vertebra. The base of the right lung, owing to the presence of the liver, holds a higher position in the chest than does the left, it being on a level with the upper border of the fifth rib near the sternum, while the base of the left lung is on a level with the upper border of the sixth rib.

The **outer, lateral, or costal surface** constitutes most of the surface of the lung. It lies against the ribs and intercostal spaces throughout its entire extent except in that portion which extends into the neck, and its form, therefore, corresponds closely to that of the bony chest, the impressions of the ribs being often distinctly discernible upon it.

The **inner or mesial surface** is deeply concave to accommodate the heart and pericardium, that of the left lung being the more marked because the greater portion of the heart is on that side. Upon this surface, above and behind the base of the heart, a little nearer the apex than the base of the lung, is a recess for the entrance of the bronchus, pulmonary and bronchial arteries and nerves, and the exit of the pulmonary veins and lymphatics; this recess is called the **hilum**.

The **anterior border** is thin and overlaps, in part, the pericardium. The borders of the two lungs lie behind the sterno-clavicular articulations, pass ob-

liquely behind the manubrium sterni, and meet in the middle line at the junction of the manubrium with the gladiolus. From this point the edge of the right lung is directed vertically downward, behind the mid-sternal line, to the junction of the sixth costal cartilages with the sternum, from which point it follows the line of the sixth rib. The anterior border of the left lung observes the same relation as that of the right, until it reaches the junction of the sternum with the fourth costal cartilage, at a point between the fifth and sixth ribs, two inches below the nipple and one inch to its sternal side, where the margin is notched corresponding to the apex-beat of the heart. On account of the presence of the thymus gland there is a greater separation anteriorly between the lungs in a young child than in the adult. The two edges of the lungs do not overlap at any place. The right reaches to the middle line and the left one to the left edge of the sternum (Symington).

The **posterior border** is full, round, and thick, being the most bulky part of the organ and lying in the deep, wide sulcus upon the side of the vertebral bodies and the angles of the ribs. It is almost twice as long as the anterior border and becomes wider as it descends.

Lobes.—Each lung is divided into an upper and a lower lobe by an oblique fissure, penetrating almost to the root, which begins behind about three inches (7.5 centimeters) from the apex and ends in the anterior border near the base. Upon the surface of the chest the position of this fissure may be indicated by a line drawn from the spinous process of the second dorsal vertebra downward and forward to where the mammillary line intersects the sixth rib. It will thus be seen that the upper and smaller lobe is formed by nearly the entire anterior portion of the lung, embracing the apex and anterior border, while the lower lobe, the larger, is formed by the posterior portion, including the base and nearly all the posterior border. On the right side the upper lobe is divided by a second nearly horizontal fissure which is directed forward from the middle of the preceding one to the anterior border, thus making, out of the right lung, three lobes. The right lung, besides having three lobes, is larger and heavier than the left; its transverse diameter is greater owing to the inclination of the heart to the left side; its vertical diameter is shorter by an inch owing to the diaphragm lying higher on the right side, being carried up by the liver. The left lung is smaller and narrower but longer than the right.

Roots.—The lungs are attached by the structures composing their roots, and by the ligamentum latum pulmonis. The structures constituting their roots are the pulmonary vessels, the bronchial vessels, the lymphatic vessels and glands, the bronchi, and the pulmonary plexuses of nerves. The ligamentum latum pulmonis attaches the portion of the lungs below the roots to the sides of the peri-

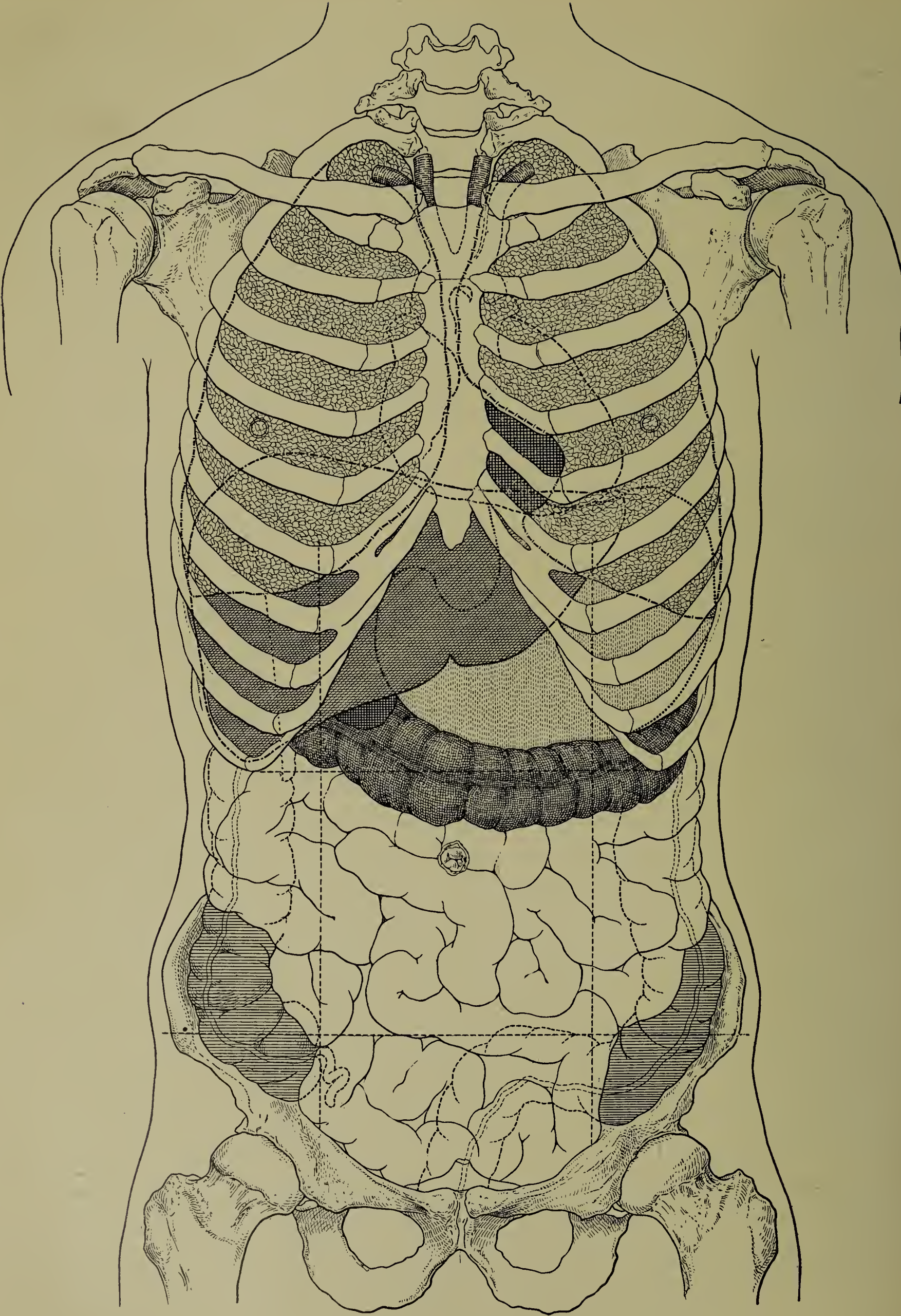


DIAGRAM OF LUNGS—ANTERIOR VIEW.

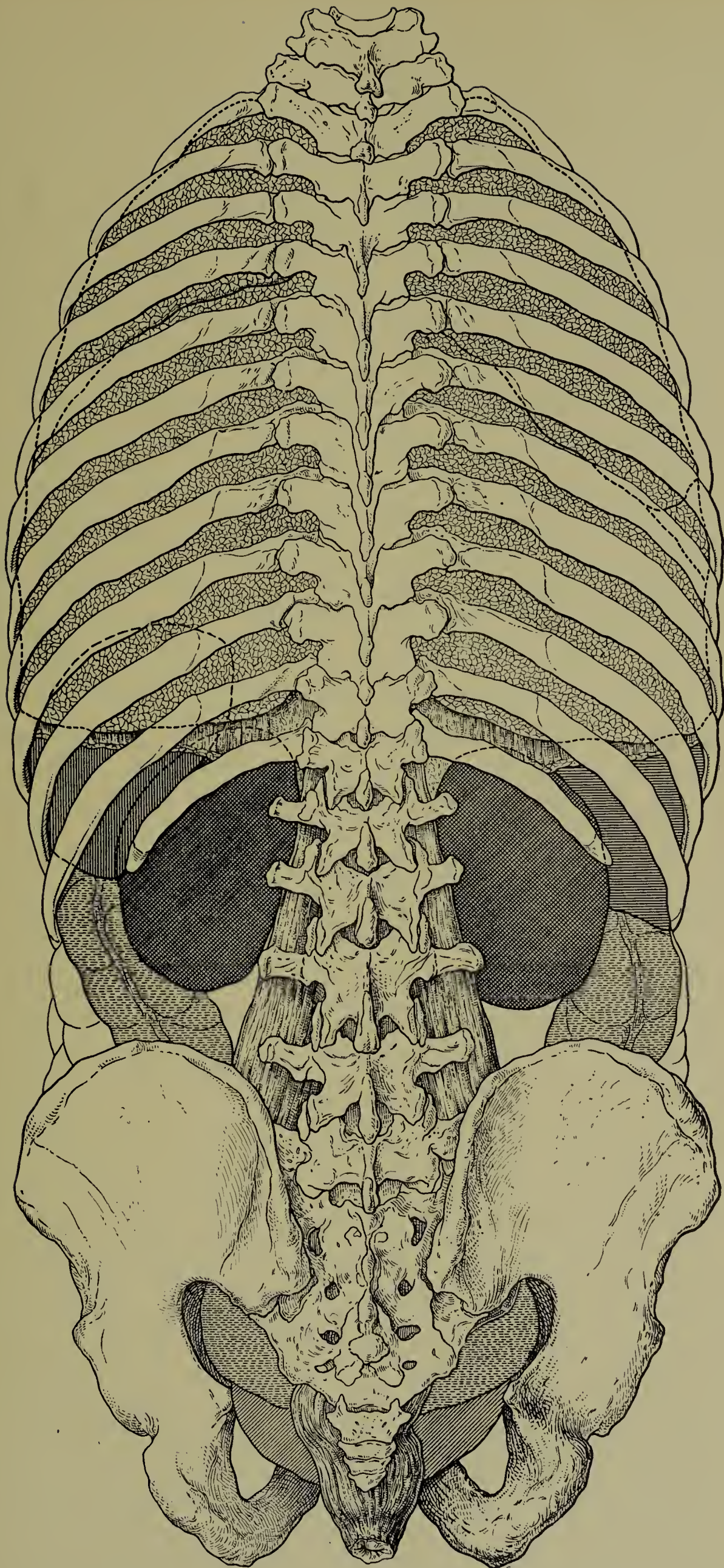


DIAGRAM OF LUNGS—POSTERIOR VIEW.

cardium and to the diaphragm at the pericardial margin. It has been described with the pleura. In front of the root of the right lung are the superior vena cava, the upper part of the right auricle, the ascending portion of the arch of the aorta, the phrenic nerve, part of the anterior pulmonary plexus of nerves, and the terminal part of the vena azygos major, which is at first behind and then winds over the upper border, terminating in front. In front of the root of the left lung are the phrenic nerve and part of the anterior pulmonary plexus, and above it is the arch of the aorta. Behind the root of each lung are the pneumogastric nerve and part of the posterior pulmonary plexus of nerves. Below the root is the ligamentum latum pulmonis. In the root are collected the bronchus, the branch of the pulmonary artery, two pulmonary veins, two bronchial arteries and their accompanying veins, the pulmonary plexus of nerves, lymphatics, bronchial glands, and areolar tissue, all of which are surrounded by pleura. The relations of the pulmonary veins, the branch of the pulmonary artery, and the bronchus in the root of each lung, from above downward and from before backward, are as follows: In the roots of both lungs, from before backward, the relations are: the pulmonary veins, the branches of the pulmonary artery, and the bronchus; from above downward, in the root of the right lung, the relation is the bronchus, the branch of the pulmonary artery, and the pulmonary veins; from above downward, in the root of the left lung, the relation is, the branch of the pulmonary artery, the bronchus, and the pulmonary veins. The difference in the relation of the two bronchi may be accounted for by the left one being at a lower level than the right in order that it may pass under the aorta.

Division of the bronchi: The right bronchus about three-fourths of an inch from its origin gives off a considerable branch, which passes above the pulmonary artery to the upper lobe of the right lung; it is known as the **eparterial bronchus**, in contradistinction to all the other branches, which come off below the pulmonary artery, and are known as **hyparterial bronchi**. There is no eparterial bronchus on the left side. The bronchus passing to the upper lobe of the left lung comes off nearly two inches (five centimeters) lower down than the eparterial bronchus; consequently it would seem that the air has more direct access to the right upper lobe, and to this fact, together with the closer proximity of that lobe to the lumen of the trachea, may perhaps be attributed the differences in the auscultatory and tactile phenomena of the upper portions of the two sides of the chest.

Each bronchus continues its course toward the lower and posterior portion of the lung, giving off in its course four "ventral" and four "dorsal" branches; the right one has an additional or "accessory" bronchus which passes into the lower lobe.

The *lungs weigh* about forty-two ounces (1260 grams), the left twenty (600

grams) and the right twenty-two (660 grams), though this is subject to considerable fluctuation, depending upon the size of the individual.

BLOOD SUPPLY.—The blood supply for the lung tissue is derived from the bronchial arteries.

NERVE SUPPLY.—The nerve supply is derived from the anterior and posterior pulmonary plexuses which are formed by branches of the vagus and sympathetic.

The *consistency of the lung* is soft, spongy, and elastic, crepitating when compressed between the fingers, and floating when placed in water. They may be compressed within a very small space or enlarged by inflation considerably beyond their maximum expansibility during life, when this is restricted by the environing walls.

The *color of the lungs* varies with age, being a clear pink in infancy, and gradually changing to a slate color in adult life, when it is mottled with dark patches of pigment. In some occupations, as in coal-mining, or in coalheavers and stokers, the lungs become almost black, the exuding fluid on section staining the hands. Most pigment is deposited at the bases and posterior borders. The surface of the lungs is finely wrinkled when partly collapsed, but smooth and glistening when fully inflated, and is covered with polyhedral markings indicating the shape of the underlying air cells.

Hernia of the lung, called pneumatocele, may follow perforating injuries of the pulmonary environment, resulting in a soft compressible tumor, resonant on percussion.

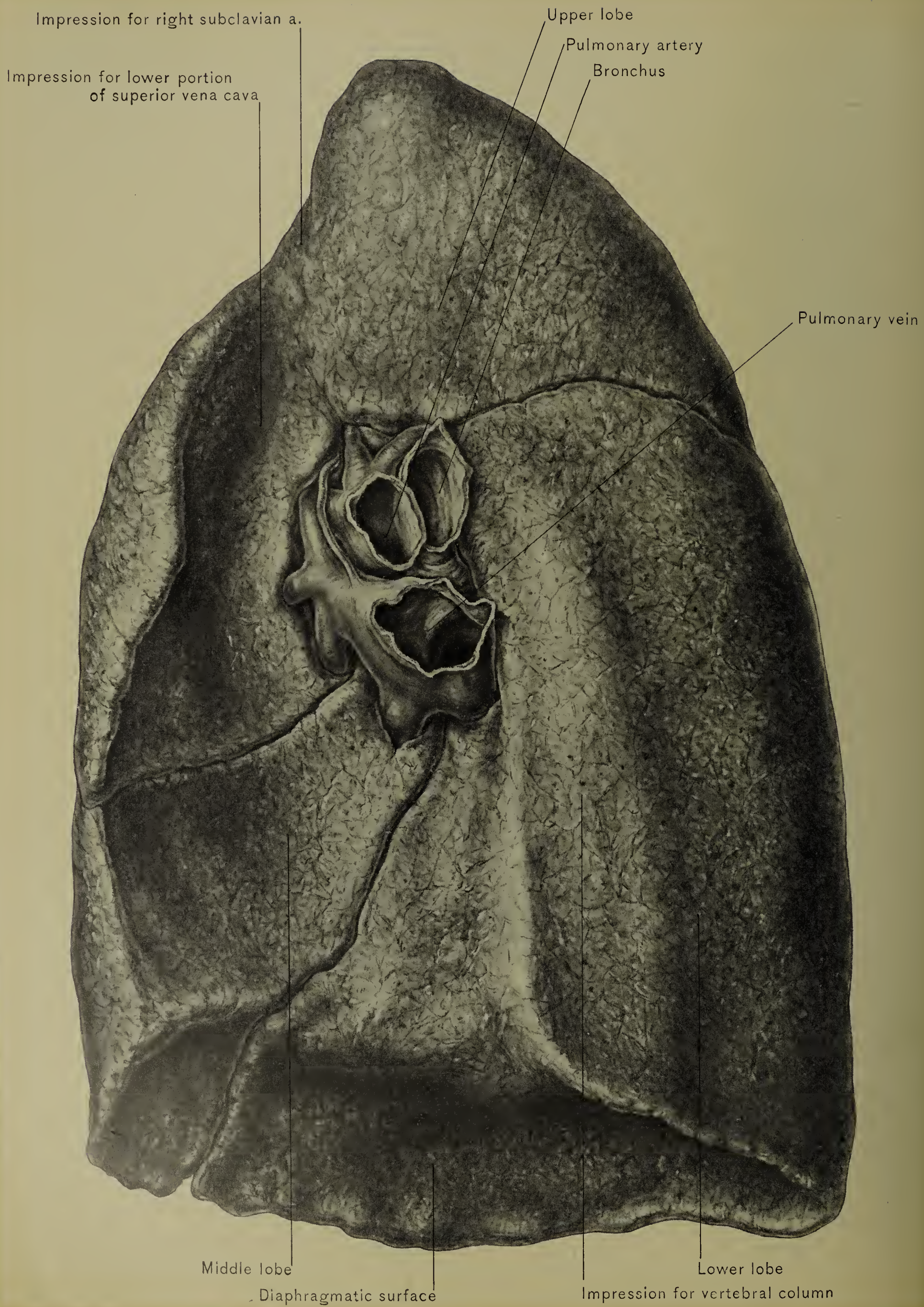
Hypostatic congestion is a soggy condition of the posterior margin and base of the lung, due partly to cardiac weakness and to the influence of gravity, and is met with in patients who have been lying in one position for a long time. The base of the lining is dark in color and on section exudes a stream of frothy pink or red serum. In advanced cases the air vesicles no longer contain air and parts of the lung sink in water; to these cases the term hypostatic pneumonia is applied.

In **pneumonitis**, or **pneumonia**, the lower lobe is usually affected, and because of the direction of the interlobular fissure, the physical signs, when the lower lobe is affected, are found upon the side and back.

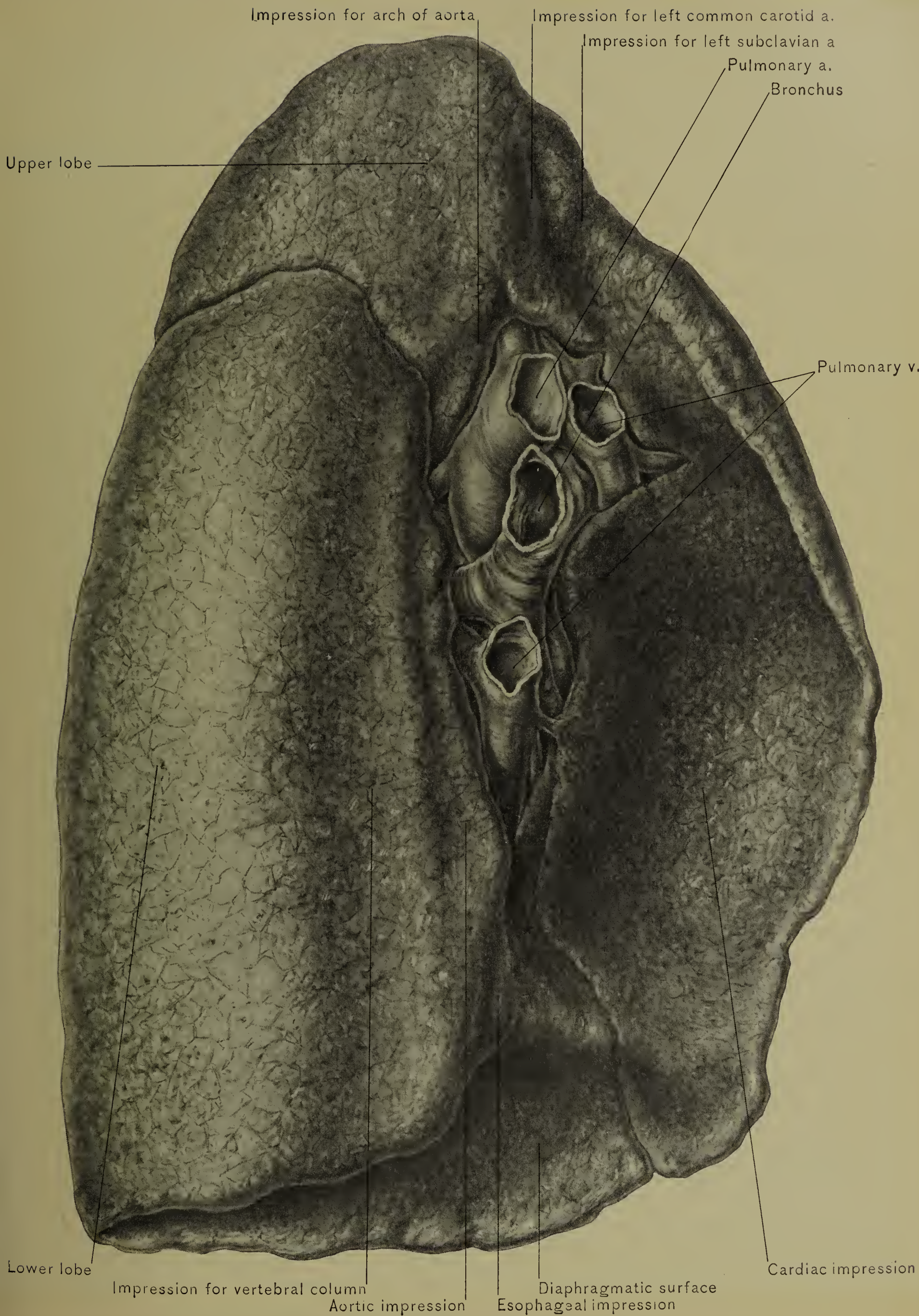
In **phthisis** the upper lobe is the one almost always primarily affected, the apex particularly. In this affection the physical signs must be looked for particularly in the front and upper part of the chest, and in the supra-scapular regions behind.

The lung has been penetrated by sword and bullet, causing wounds that have ended in complete recovery by rational local and supporting general treatment.

Infarctions of the lung are marked by their pyramidal shape, with the apex



MEDIASTINAL SURFACE OF RIGHT LUNG.



MEDIASTINAL SURFACE OF LEFT LUNG.

always directed toward the interior of the lung, and the base invariably extending to the surface. This is due to the shape of the area of distribution of the pulmonary arteries which branch out symmetrically in all directions, so that when one of them becomes suddenly clogged by a clot of blood, the entire distributive area beyond is cut off from further supply, for the inosculations of these vessels are meager and not sufficient to carry on a collateral circulation. The lung is the only organ that can have an infarct due to a clot formed in a systemic vein, though the liver may be damaged in part by an embolus in the portal vein. A pulmonary infarct may end in gangrene, or abscess, or may become organized and decolorized.

Emphysema is a condition in which the air cells are ruptured and part of them destroyed from increased intra-pulmonary pressure, which may be caused by playing upon wind instruments, by whooping-cough, and by chronic coughs generally. By this unusual distention of the lung its elasticity is diminished so that it does not collapse post mortem. The gradual destruction of its aerating surface, by the breaking down of its vascular walls and the coincident disappearance of their contained capillaries, renders its victims "short-winded" despite their enlarged chests being distended by the increased pressure. Emphysematous lungs often overlap behind the sternum and bear the indentations of the ribs. When the rupture of a vesicle permits the air to get into the connective tissue of the lung, it may eventually extend into the connective tissue of the neck and face, and finally over the entire body.

Asthma may be due to old age with its resulting absorption of vesicle walls, or to bronchitis causing narrowing of the bronchial tubes by adhesion of sticky mucus, and by spasmodic contraction of the muscular fibers surrounding the bronchi, thus narrowing them. This spasm may be caused by irritations of the various filaments of the vagus nerve, whether it be the gastric filaments in dyspepsia, the laryngeal branches in throat affections, or other reflexes. To successfully treat this disease, therefore, requires the certain discovery of its cause, to which remedial measures must be directed. This is a problem in applied anatomy that always brings its reward to the master of a knowledge of body structures.

THE POSTERIOR MEDIASTINUM.

The **posterior mediastinum** is the space running parallel with the vertebral column, bounded in front by the pericardium and the posterior surface of the roots of the lungs; behind, by the vertebral column; and on either side, by the pleura. It extends from the level of the lower border of the fourth thoracic vertebra to the diaphragm.

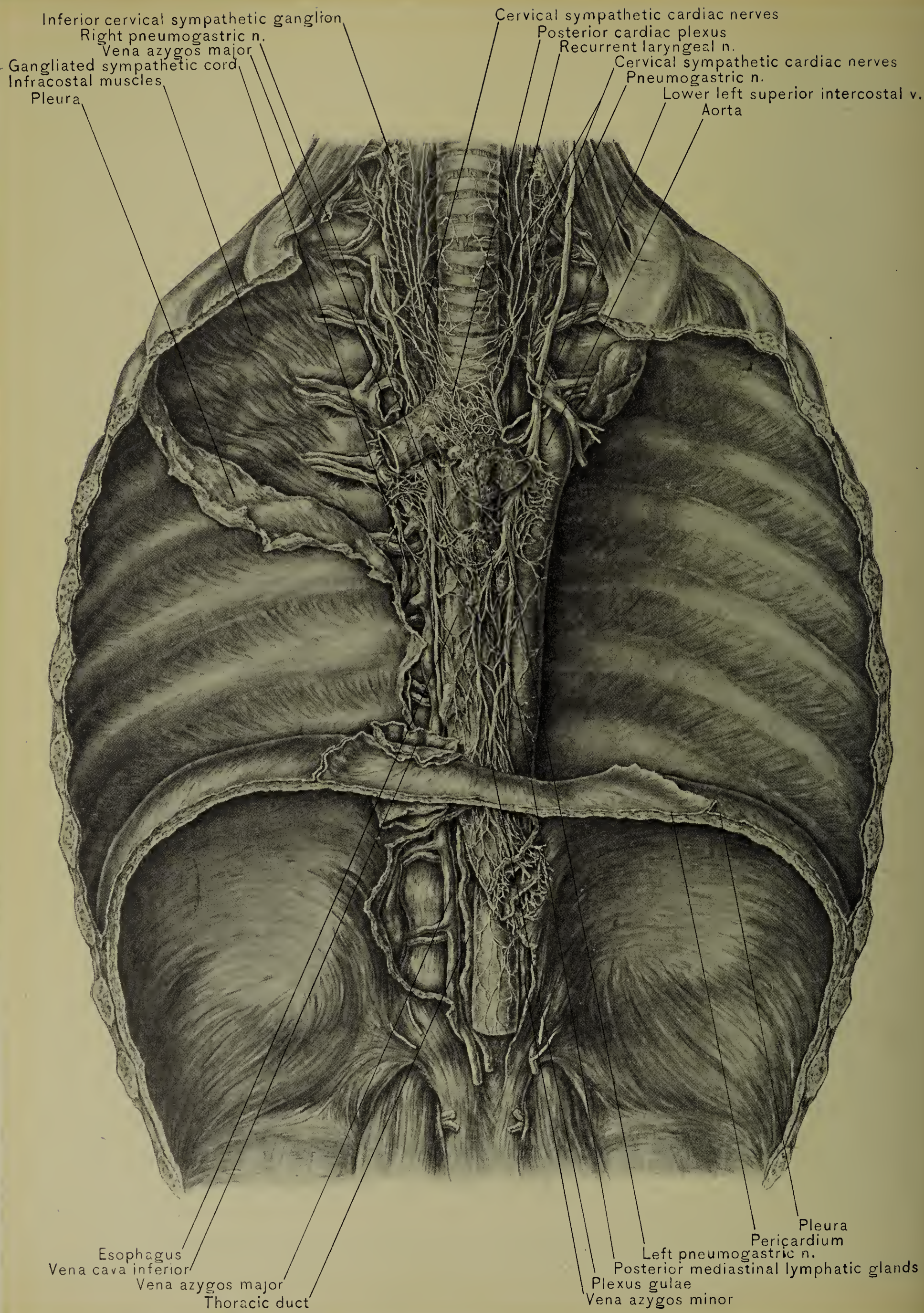
DISSECTION.—The posterior mediastinum should be studied from in front and from both sides. It will be necessary, therefore, to remove the heart, the pericardium, and the lungs, as well as a portion of the ribs as far back as the angles. To expose the contents of the posterior mediastinum from the right side, the ribs on the right side are to be cut away as far as their angles, and the right lung lifted out of the chest cavity and displaced to the left; the posterior part of the costal pleura, as well as the pleura covering the posterior surface of the root of the right lung and the ligamentum latum pulmonis, are then to be removed. By careful dissection, the greater part of the space and its contents, with the exception of the upper portion of the descending thoracic aorta, and the left upper and left lower azygos veins, with some of the left aortic intercostal arteries and veins, will be exposed. The same thing should then be done on the left side, the left lung displaced to the right, and the aorta and its branches, and the vena azygos tertia and the lower left vena azygos studied. After removal of the lungs the posterior mediastinum should be studied from in front.

CONTENTS.—The contents of the posterior mediastinum are the descending or thoracic aorta with the vertebral portion of the right and left intercostal arteries, the origin of the bronchial, pericardiac, esophageal, and mediastinal arteries; the arteria aberrans (when present), part of the bronchial veins, the lower portions of the esophagus, the pneumogastric nerves, and the thoracic duct; the sympathetic nerve, the splanchnic nerves, the lymphatic glands, the left upper (vena azygos tertia) and left lower azygos veins, the vena azygos major, and the posterior pulmonary plexus.

The Thoracic Aorta.—The thoracic aorta extends from the lower border of the fourth thoracic vertebra to the aortic opening in the diaphragm opposite the twelfth thoracic vertebra. From there it continues as the abdominal aorta. At first it lies to the left of the dorsal spine, but gradually approaches the middle, so that at the diaphragm it lies nearly in the median line.

RELATIONS.—In front of it are the root of the left lung, which crosses it, the esophagus, the pericardium, and the heart; and, below, the diaphragm. Behind it are the bodies of the lower thoracic vertebræ joined by the anterior common ligament. The vena azygos minor usually crosses behind it at the seventh, eighth, or ninth dorsal vertebra, and the lower end of the lower superior intercostal vein, or the vena azygos tertia, or one or more left intercostal veins cross behind it at the fifth, sixth, or seventh thoracic vertebra. On the right side are the esophagus, pleura, and lung, and a little behind and to the right are the vena azygos major and the thoracic duct.

On the left side are the pleura, lung, esophagus, and the upper and lower left azygos veins.



THE POSTERIOR MEDIASTINUM, VIEWED FROM THE FRONT.

The esophagus at first lies to the right of the aorta, but as these structures approach each other in their course downward and inward the esophagus comes to lie in front of the aorta, and at the diaphragm even a little to the left of it.

The branches of the thoracic aorta are the intercostal and subcostal, the bronchial, pericardial, esophageal, mediastinal, and diaphragmatic arteries, and the arteria aberrans.

The **intercostal arteries** number ten on each side. The upper nine intercostals of each side supply the lower nine intercostal spaces, while the tenth lies below the twelfth rib and is named the **subcostal artery** (Walsham). The upper two intercostal spaces are usually supplied by the superior intercostal artery, a branch of the subclavian. The right intercostal arteries are longer than the left, since the thoracic aorta lies to the left of the median line of the vertebral column. They are given off from the posterior part of the aorta and run outward across the bodies of the vertebra to the intercostal spaces; those of the right side pass behind the esophagus, the thoracic duct, the vena azygos major, the sympathetic nerve, and the pleura; those of the left side pass behind the left superior intercostal vein, the left upper and the left lower azygos veins, the sympathetic nerve, and the pleura. The upper two or three left aortic intercostal arteries may come off from the aorta by a single stem. In the intercostal spaces each artery divides into two branches, an anterior and a posterior. The anterior branches anastomose with the anterior intercostal and musculo-phrenic branches of the internal mammary. These arteries have been described with the thoracic wall.

The **bronchial arteries**, two or more, are the nutrient vessels of the lung. The right bronchial artery arises either in common with one of the left bronchials from the thoracic aorta or alone from the first aortic intercostal. The left bronchial arteries, usually two in number, arise from the thoracic aorta. Each vessel runs along the back part of the corresponding bronchus, to which it adheres, and ramifies upon the bronchial tubes, supplying them, the areolar tissue of the lungs, the bronchial glands, and the esophagus.

The **bronchial veins** receive the blood that has been supplied by the bronchial arteries for the nourishment of the lungs, the right conveying its contents to the vena azygos major just before it joins the vena cava, and the left, to the left superior intercostal.

The **pericardial arteries** are a few small vessels distributed to the posterior part of the pericardium and to the posterior mediastinal glands.

The **esophageal arteries**, four or five, arise at different points from the front of the thoracic aorta and pass obliquely downward to the esophagus, around which they ramify. They anastomose with one another, with the esophageal branches

of the inferior thyroid above, and with branches of the gastric and phrenic below. They supply the walls of the esophagus.

The **mediastinal arteries** (posterior) arise from the back part of the thoracic aorta and go to the lymphatic glands and loose connective tissue in the posterior mediastinum.

The **diaphragmatic branches** are small vessels given off near the diaphragm to supply the upper surface of the vertebral portion of that structure.

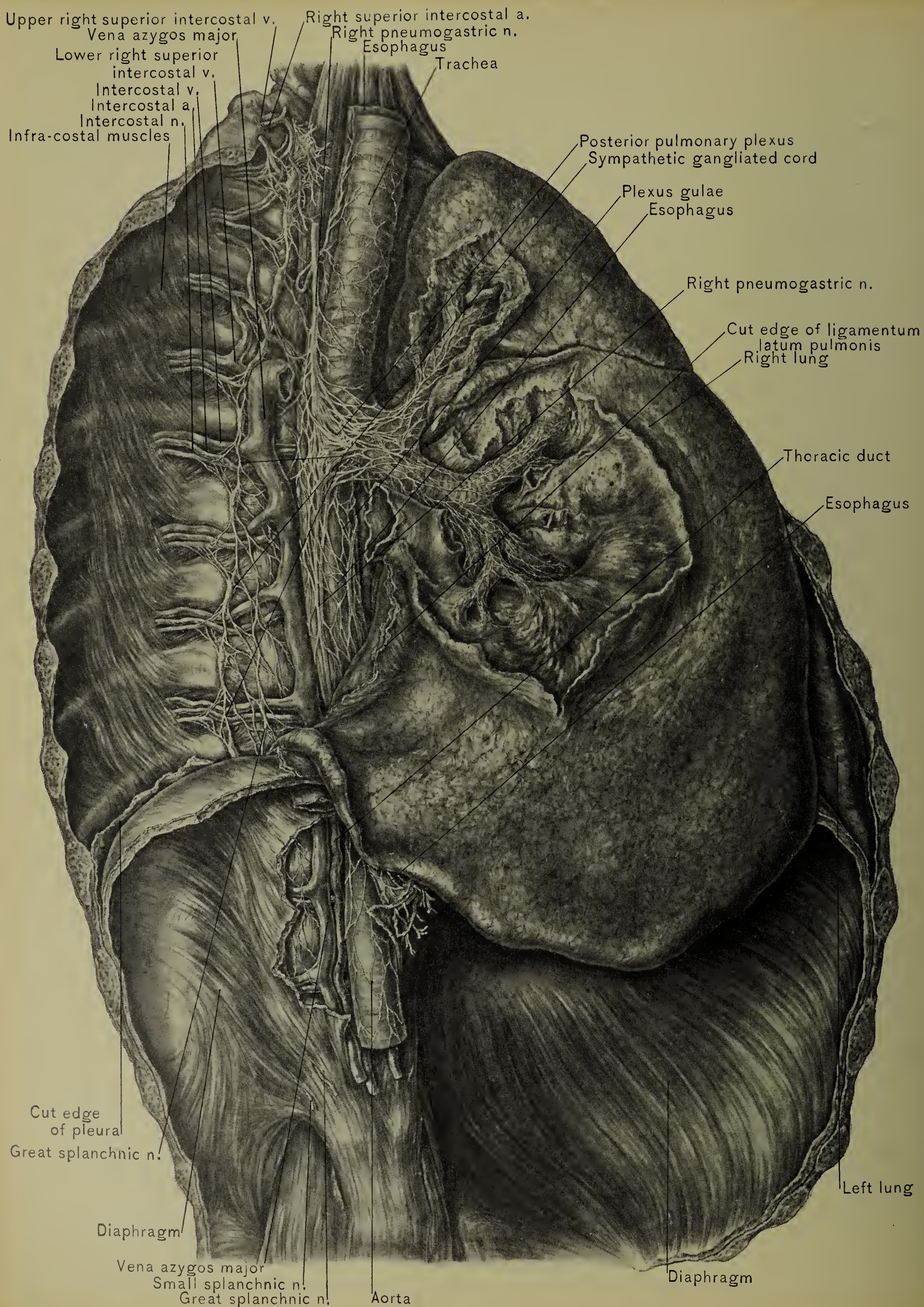
The **arteria aberrans** is regarded as the remains of the right aortic stem; it is a small vessel that passes upward behind the esophagus and frequently anastomoses with the arteria aberrans of the superior intercostal artery.

Aneurysm of the aorta is of frequent enough occurrence to be sought for in all who have passed the meridian of life. If the descending aorta be affected, it may cause erosion of the bodies of the thoracic vertebræ resulting in spinal curvature; it may irritate the intercostal nerves and cause pains that are often referred to other causes. It is well to remember, also, that the neuralgia of vertebral caries is bilateral, while that resulting from aortic aneurysm is more likely to be unilateral. Its bruit may be heard at the costal angles behind, where it may also be seen pulsating, if large. Anteriorly it may push the esophagus forward, or compress the lung, or embarrass the heart, causing dysphagia, dyspnea, palpitation, and circulatory disturbances. Compression of the thoracic duct causes rapid wasting—a significant sign. Finally, the aneurysm may rupture, with fatal hemorrhage, through the skin, or into the mediastinum, esophagus, pleura, pericardium, or one of the bronchi.

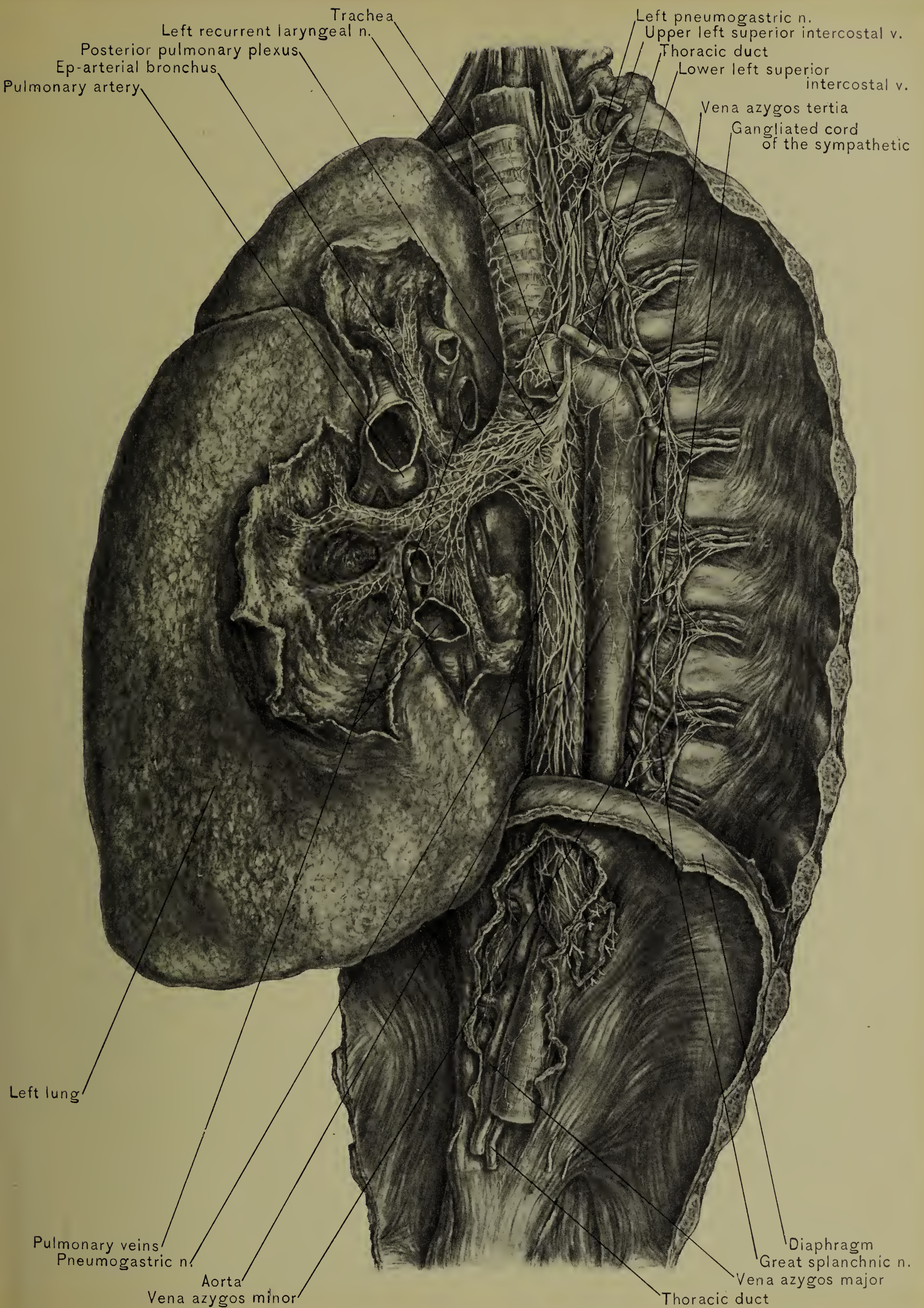
The **Esophagus, or Gullet**, is a hollow muscular tube about ten inches (25.0 centimeters) in length. It commences at the termination of the pharynx, on a level with the lower border of the cricoid cartilage opposite the fifth or sixth cervical vertebra, and ends at the cardiac opening of the stomach, opposite the eleventh dorsal vertebra. It has been described with the superior mediastinum and neck. In the posterior mediastinum it lies at first to the right side of the thoracic aorta and at the diaphragm passes in front of the thoracic aorta and into the abdomen through the esophageal opening of the diaphragm.

The **pneumogastric nerves**, which accompany the esophagus, form a plexus, the *esophageal plexus*, or *plexus gulæ*, which surrounds it. Each nerve then descends as two cords along the esophagus, the left nerve at first to the left side of and later in front of the esophagus, the right nerves to the right side of and behind the esophagus. Beyond the plexus gulæ each nerve descends as a single trunk, the left to the anterior, the right to the posterior surface of the stomach.

The **thoracic duct** conducts the lymph from the receptaculum chyli, in front of the body of the second lumbar vertebra, to the left internal jugular vein at its



THE POSTERIOR MEDIASTINUM, VIEWED FROM THE RIGHT SIDE.



THE POSTERIOR MEDIASTINUM, VIEWED FROM THE LEFT SIDE.

union with the subclavian. The receptaculum chyli is an irregularly elongated expansion of the lower end of the duct lying upon the second lumbar vertebra posterior to the aorta. The duct is found in the loose tissue between the vena azygos major and the aorta. It is very elastic and no larger than a whipcord. It passes through the aortic opening of the diaphragm on the right of the aorta, then ascends with a gradual sinistral inclination that brings it behind the aortic arch and esophagus opposite the body of the fourth thoracic vertebra, from which point it continues upward in the superior mediastinum to the left of the esophagus. The duct contains valves, mostly in its upper part. It may divide into several branches during its ascent, which usually reunite before its termination in the internal jugular vein, though instances have been met with where it emptied by two or more orifices. It leaves the thorax upon the left of the esophagus until opposite one of the last two cervical vertebræ, where it bends outward and forward, and then downward to the pleural apex, thus reaching its destination. Its arch is higher than the subclavian artery. A double valve guards its entrance into the vein. The duct may be injured in operations on the lower part of the neck or may be compressed by growths in the posterior mediastinum.

The **vena azygos major** begins in the abdomen and is the continuation of the right ascending lumbar vein. Entering the thorax through the aortic opening in the diaphragm, it runs upward in the posterior mediastinum to the right side of the bodies of the thoracic vertebræ to the fourth thoracic vertebra, where it arches forward over the right bronchus to empty into the superior vena cava, just above the pericardial investment of the latter.

RELATIONS.—In the abdomen it lies behind the right crus of the diaphragm upon the first or second lumbar vertebra, and to the right of the thoracic duct and the abdominal aorta. It may communicate with the renal vein, or the inferior vena cava, and, by means of the ascending lumbar vein, connects the iliac veins with the superior vena cava. In the posterior mediastinum it lies to the right of the esophagus and aorta, and in front of the lower right intercostal arteries and the thoracic vertebræ. On its right side are the pleura and lung, and in front of it are the root of the right lung and the pleura. Its valves are imperfect.

It receives the vena azygos minor; the vena azygos tertia, or some of the left intercostal veins; the lower end of the lower left superior intercostal vein occasionally; the lower esophageal veins of the right side; the right bronchial vein; the lower right superior intercostal vein; the mediastinal veins; the nine lower intercostal veins of the right side; and the right subcostal vein.

The **vena azygos minor**, also called the **lower left azygos vein**, or **vena hemiazygos**, begins at the left ascending lumbar vein in the abdomen and ends by emptying into the vena azygos major, thus establishing communication between

the iliac or renal vein below and, through the vena azygos major, the superior vena cava above. It enters the thorax behind or through the left crus, and in its course upward in the posterior mediastinum, lies to the left of the bodies of the lower seventh or eighth thoracic vertebræ, and passes in front of the lower intercostal arteries. It may cross at various levels behind the esophagus, thoracic duct, and aorta, but probably most usually at the eighth dorsal vertebra, to empty into the vena azygos major. It may communicate with the lower end of the vena azygos tertia when that vessel is present. It is covered by pleura.

Into it empty the left subcostal vein, the lower three or four intercostal veins, the lower end of the vena azygos tertia occasionally, small mediastinal veins, and the lower left esophageal vein.

The **vena azygos tertia, upper left azygos vein, or vena hemiazygos accessoria**, also lies in the posterior mediastinum, to the left side of the bodies of the fifth, sixth, or seventh thoracic vertebræ. Above it communicates with the lower left superior intercostal vein and below very frequently with the vena azygos minor, or with the vena azygos major after crossing to the right side at the sixth or seventh thoracic vertebra. This vein varies considerably in size and arrangement, and may be absent. In the latter event the left intercostal veins intervening between the lower left superior intercostal vein and the vena azygos minor cross in front of the spinal column to empty into the vena azygos major. This vein crosses some of the left intercostal arteries and is covered by pleura.

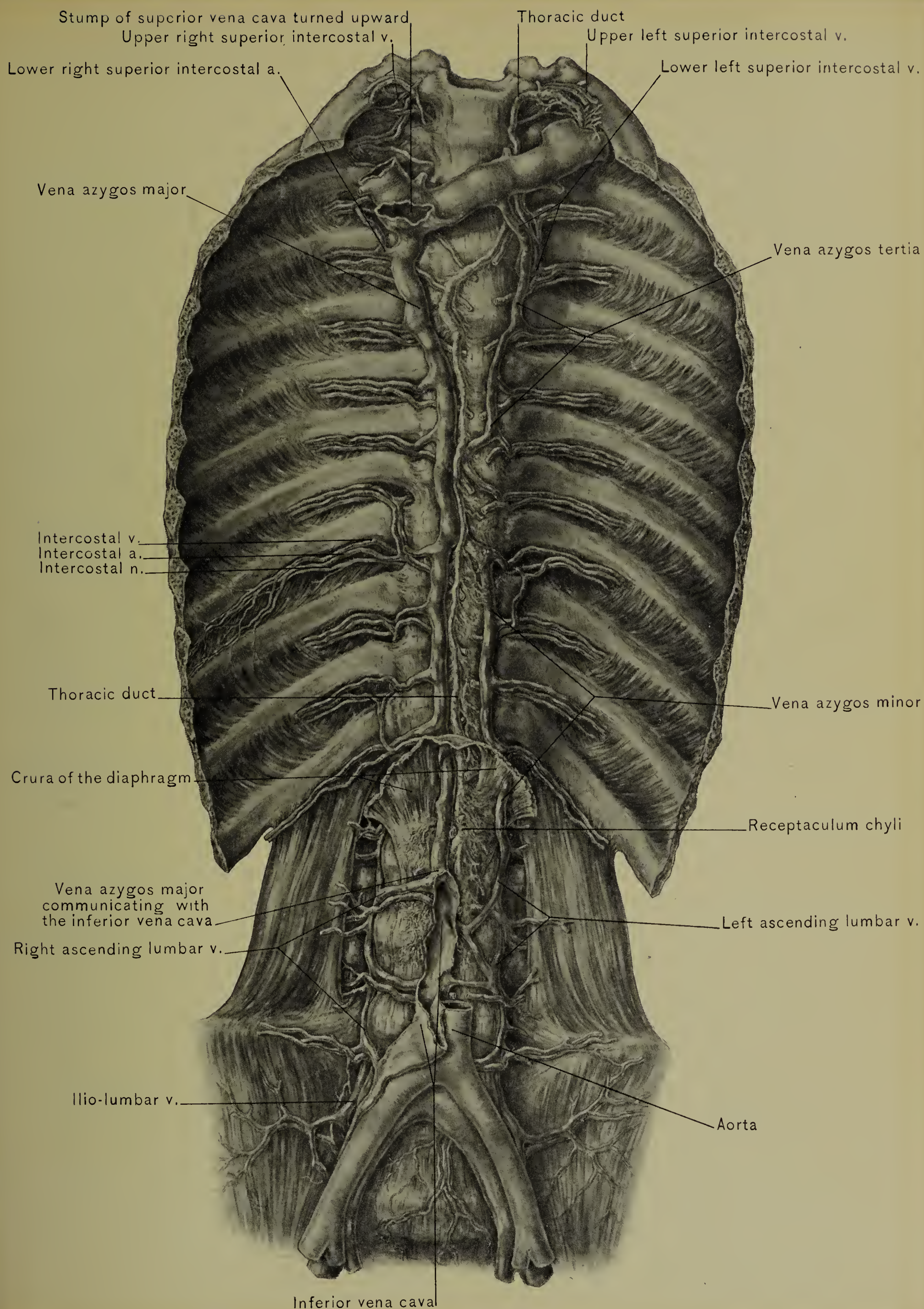
Into it empty usually the fifth, sixth, and seventh left intercostal veins, the left bronchial vein, and the lower left superior intercostal vein. It frequently communicates by its lower end with the vena azygos minor, or with the vena azygos major by crossing in front of the spinal column.

The **intercostal veins** have been described with the thoracic walls.

The **thoracic sympathetic**, in addition to the pulmonary and cardiac plexuses, consists of the double chain of ganglia that lie on either side of the spinal column near the heads of the ribs. There is one ganglion upon each rib close to its head, and these are connected by non-medullated nerve-fibers; the lower two lie on the dorsal vertebræ. The upper six ganglia supply mainly the thoracic aorta, while the lower six do likewise and also supply the abdominal viscera through the splanchnic nerves. All communicate by two or more external branches apiece (rami communicantes) with the corresponding intercostal nerves.

The **great splanchnic nerve** is formed by branches from the sixth to the tenth thoracic ganglia, passes through the crus of the diaphragm to the semilunar ganglion, and sends branches to the renal and suprarenal plexuses.

The **lesser splanchnic nerve** arises from the tenth and eleventh ganglia, perforates the crus of the diaphragm with the former, and goes to the celiac plexus.



THE VENÆ AZYGOS, THORACIC DUCT, INTERCOSTAL VESSELS AND NERVES.

The **smallest splanchnic nerve**, also called renal, originates in the twelfth ganglion, pierces the diaphragm, and ends in the renal plexus and lower part of the celiac plexus. It is frequently absent.

The *lymphatic glands* found in the posterior mediastinum are the *posterior intercostal glands* and the *posterior mediastinal glands*. The former receive the lymphatics from the intercostal space, spinal canal, part of the diaphragm, and back, and are found in the posterior end of the interspace near the head of the ribs. The efferent vessels of the left and the lower right glands empty into the thoracic duct. Those of the upper right glands may join the efferent bronchial lymphatics to empty into the right lymphatic duct. The posterior mediastinal glands, situated along the aorta and esophagus, receive the lymphatics from the back of the pericardium and left side of the heart, from the esophagus, from the posterior part of the diaphragm, and from a part of the right lobe of the liver. Their efferent vessels pass to the thoracic duct, a few only to the bronchial lymphatics.

These lymph glands may become enlarged, giving rise to pressure symptoms. They may be the seat of secondary carcinoma.

The **Joints of the Thorax**, from behind forward, are: thirty-five between the bodies and articular surfaces of the thoracic vertebræ, forty-four between the vertebral bodies and their transverse processes, with the ribs, fourteen between the costal cartilages and the sternum, ten between the cartilages of the lower true and upper false ribs, and two between the sternum and clavicles, being a total of one hundred and five, all of which, except the two sterno-clavicular joints, permit but very limited motion. This enumeration does not include possible joints at either or both ends of the gladiolus sterni.

The **Ligaments of the Vertebral Bodies** are the anterior and the posterior common ligaments, and the intervertebral substance.

The **anterior common ligament** is a thick, broad fibrous band attached along the front of the vertebral bodies, prolonged upward and downward over the cervical and lumbar vertebræ, where it is narrower than in the chest. It is firmly united to the front edge of the intervertebral substance and adjacent edges of the bodies of the vertebræ, but is loosely attached between the edges of each body, where it is also thickest and serves to fill the anterior vertical concavities. It is composed of layers of longer and shorter fibers extending between adjacent and more distant vertebræ, the deepest and most lateral being the shortest, and the most superficial the longest, extending between four or five vertebræ.

The **posterior common ligament** is arranged like the preceding except that it is narrower and placed upon the back of the bodies of the vertebræ along the anterior wall of the spinal canal, being separated from a portion of each vertebra by the venæ basis vertebræ. It is separated from the dura mater of the

spinal cord by loose connective tissue which is sometimes the seat of a serous infiltrate.

The **intervertebral substance** is composed of concentric layers of fibrous tissue and fibro-cartilage, with their edges facing the adjacent vertebræ (called *annulus fibrosus*), and within them a soft, pulpy, highly elastic mass (called *nucleus pulposus*). Of the concentric layers, the outer ones bulge outward and the inner ones inward. These intervertebral segments act as buffers, and are thicker behind than in front, in the thoracic region, thus assisting to form the backward bend of the thoracic portion of the column.

The laminae are united by the **ligamenta subflava**, which extend almost vertically from the lower margin of the upper lamina to the top and back of the lamina below, throughout their entire length.

The articular processes are united by a **capsular ligament** attached to their circumference except upon their inner side, where the capsule is replaced by part of a ligamentum subflavum. The capsular ligament is lined with synovial membrane.

The spinous processes are united by a strong fibrous **supraspinous ligament** extending across the tips of the spines, its fibers being of varying length, with arrangements similar to the anterior and posterior common ligaments. The spines are also united by their membranous **interspinous ligaments**, connecting the adjacent margins of the spines of adjoining vertebræ.

The **intertransverse ligaments** are round fibrous cords extending between the transverse processes.

The joints between the heads of the ribs and the vertebral bodies have an anterior costo-vertebral, a capsular, and an interarticular ligament.

The **anterior costo-vertebral** or **stellate ligament** consists of three radiating fibrous bands attached to the front of the head of the ribs, whence they diverge inward for attachment to the sides of the vertebral body immediately above and below, and to the intervertebral substance between them, opposite the head of the rib. The thoracic sympathetic ganglia lie upon them, and also the vena azygos major on the right side. Behind them are the synovial membranes and interarticular ligaments.

The **capsular ligament** is a very thin and loose bag, deficient in front, where it is replaced by the preceding ligament. It is attached to the margins of the joint and is thickest on top.

The **interarticular ligament** extends between the sharp crest on the head of the rib and the intervertebral substance, thus dividing the joint into two cavities, lined by two distinct and non-communicating synovial sacs; it does not exist in the joints of the first, tenth, and twelfth ribs, as the intervertebral substance does not enter into their formation.

The joints between the costal neck and tubercle and the vertebral transverse process have the following four ligaments: the anterior, middle, and posterior costo-transverse, and the capsular.

The **anterior costo-transverse ligament** consists of strong, short fibers extending between the upper surface of the costal neck and the lower edge of the transverse process above it, its lower or costal attachment being the wider. The intercostal vessels and nerves pass it in front, and the longissimus dorsi muscle hugs it behind. Its inner edge, together with the outer side of the articular process, forms an opening for the transmission of the posterior branches of the intercostal vessels and nerves. It does not exist at the first and last ribs.

The **middle costo-transverse or interosseous ligament** lies behind the preceding, and extends from the top of the back of the costal neck to the front of the transverse process above. It is rudimentary at the last two ribs.

The **posterior costo-transverse ligament**, short, thick, and strong, connects the tip of the transverse process with the rough portion of the costal tubercle. It varies in direction according to location, changing from an ascending course above to a descending one below.

The **capsular ligament** is attached to the adjacent peripheries of the joint surface of the costal tubercle and transverse process, and is lined with a synovial membrane.

The chondro-sternal joints have anterior and posterior, superior and inferior chondro-sternal and capsular ligaments.

The **anterior chondro-sternal (costo-sternal) ligaments** are attached to the front of the sternal ends of the costal cartilages of the true ribs, whence they diverge for attachment to the adjacent part of the front of the sternum, and to blend with those of the other side, and with the tendinous origin of the pectoralis major muscle.

The **posterior chondro-sternal (costo-sternal) ligaments** are the counterparts of the preceding at the back of the chondro-sternal joints, but are less distinct, and blend with the subjacent periosteum.

The **superior and inferior ligaments**, strong, well-marked bands, connect the upper and lower borders of the cartilage, respectively, with the lateral edges of the sternum. Owing to the close proximity of some of the cartilages, these ligaments are very closely allied, the superior ligament of the seventh even blending with the inferior of the sixth.

The **capsular ligaments** are united to the edges of the chondro-sternal joints, blend with the anterior and the posterior ligaments, and are strengthened by a few fibers above and below, extending between the sternum and cartilage.

The **synovial membrane** varies at some of the joints, the first (uppermost)

chondro-sternal joint having none; the second having two synovial membranes, one for each segment of the sternum; the third also having two; the remaining four having one each.

The **interchondral joints** are formed by the union of the seventh, eighth, ninth, and tenth costal cartilages by their adjacent margins, and usually by a separate joint between the sixth and seventh, and sometimes the fifth and sixth. They are united by a capsule lined with synovial membrane, the most constant joints being between the sixth, seventh, eighth, and ninth cartilages.

The **costo-chondral union** is secured by the union of periosteum and perichondrium.

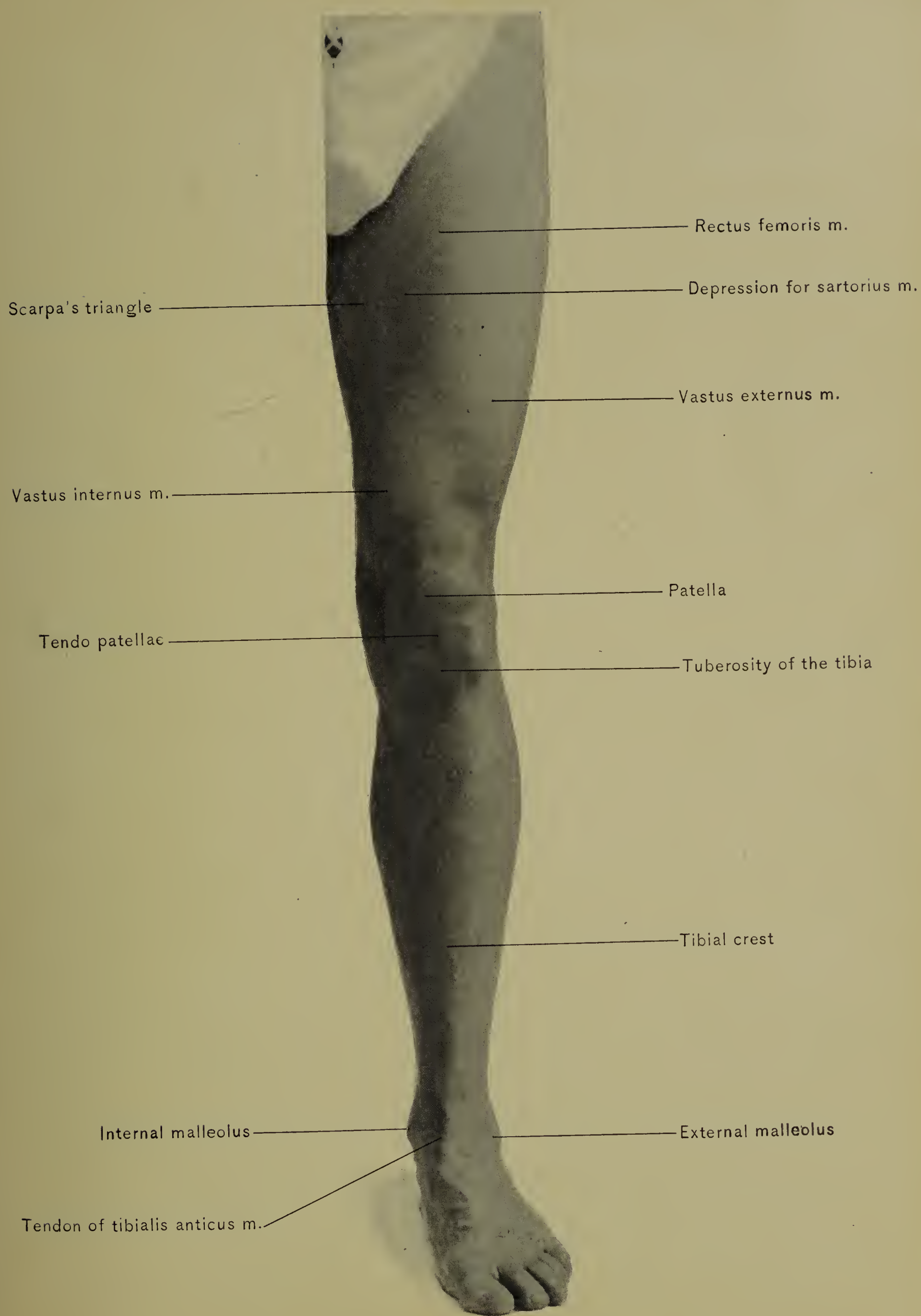
Anterior and posterior sternal ligaments, running longitudinally, the latter the less marked, are found. They blend with adjoining fibrous tissue and are not so needful in adult life as during earlier years, when the different parts of the sternum are not yet united.

THE LOWER EXTREMITY.

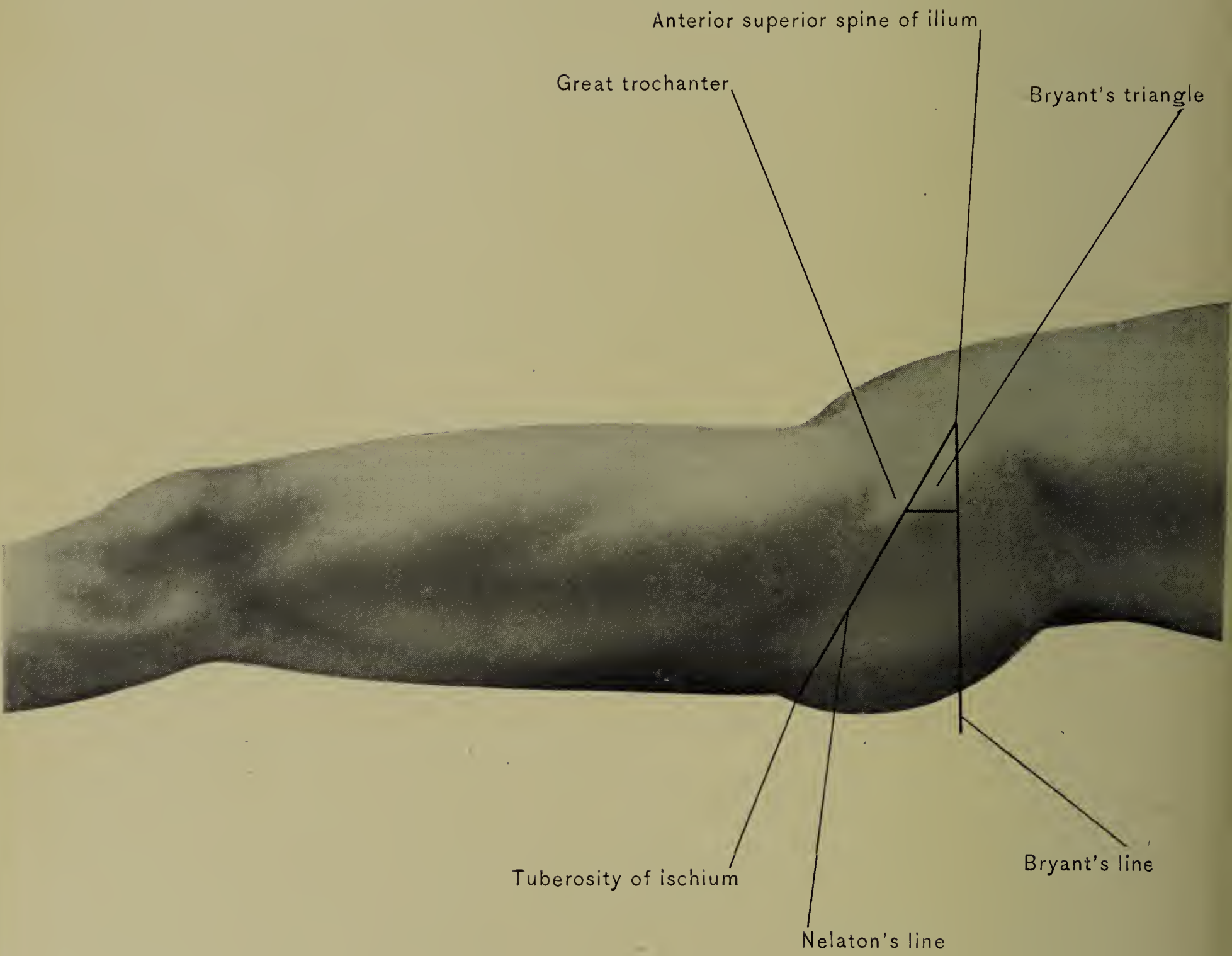
SURFACE ANATOMY OF THE LOWER EXTREMITY.

The **Thigh** is a truncated cone which extends from its beginning at the lower part of the trunk to the knee-joint. Its upper limits are formed by Poupart's ligament in front; by the crest of the ilium, the sacrum, and the coccyx on the outer side and behind; and by the rami of the ischium and pubis on the inner side. **Poupart's ligament**, or **the crural arch**, can generally be felt by making pressure in the inguinal furrow. The ligament is formed by the lower border of the aponeurosis of the external oblique, extending from the anterior superior spine of the ilium to the spine of the pubis. The latter point, even in fat subjects, can always be felt, and is a valuable guide to the differential diagnosis between the femoral and the inguinal variety of hernia. Its course is represented by a line drawn from the anterior superior spine of the ilium to the spine of the pubis, with a slight convexity downward. It forms the base of Scarpa's triangle. Its position in relation to a hernia occurring in this region is important. In the inguinal variety the hernia makes its appearance above the ligament; in the femoral, below it. A chain of lymphatic glands is found parallel with Poupart's ligament, inflammation of which constitutes inguinal adenitis, or bubo.

Immediately below the furrow indicating the position of Poupart's ligament a second furrow appears when the thigh is slightly flexed upon the abdomen. It extends upward and outward from the junction of the scrotum with the thigh



SURFACE MARKINGS OF ANTERIOR ASPECT OF LOWER EXTREMITY.



BRYANT'S AND NELATON'S LINES.

and gradually disappears between the great trochanter and the anterior superior spine of the ilium. It is a valuable landmark in amputation of the thigh by the transfixion method, as it crosses the front of the capsule of the hip-joint. The knife should be carried in the direction of this furrow, from without inward. Pressure over this furrow, to the inner side of the anterior superior spine of the ilium, elicits marked tenderness in hip-joint disease. The furrow is obliterated by distention of the joint from effusion. If deep pressure be made over this furrow at a point a little below the middle of Poupert's ligament, the head of the femur may be felt rotating when the limb is rotated on its long axis.

The **spine of the pubis** and the **anterior superior spine of the ilium** are important landmarks. The measurements of the lower limb are usually taken from either of these spines to the tip of the inner malleolus, the iliac spine being the one generally used. Pressure upon the anterior superior iliac spines is of great diagnostic value in suspected fracture of the pelvis. On the outer side of the thigh, about four inches (ten centimeters) below and posterior to the anterior inferior spine of the ilium, below a depression, a well-marked prominence, **the great trochanter**, can be very easily felt, especially if the limb be slightly rotated outward. The great trochanter, with the exception of the fascial insertion of the gluteus maximus muscle and an intervening bursa, is subcutaneous. The top of this process is almost on a level with the pubic spine, and about three-fourths of an inch (1.9 centimeters) lower than the top of the head of the femur. Its relation to the other bony prominences in this region is a most valuable aid in the diagnosis of injuries or diseases of the hip-joint and the neck of the femur. The following lines are used in determining whether or not the great trochanter holds its normal position: **Nélaton's line** passes from the anterior superior spine of the ilium to the tuberosity of the ischium, and crosses the top of the great trochanter. The non-alignment of these three bony points indicates displacement of the great trochanter, as in dislocations and fractures. **Bryant's triangle**: "Mr. Bryant made use of the following in deciding the position of the great trochanter: The patient being flat on his back, (1) a line is dropped vertically to the couch from the anterior superior spine of the ilium; (2) from the top of the great trochanter a straight line in the long axis of the thigh is drawn to meet the first; (3) to complete the triangle, a line is drawn from the anterior superior spine of the ilium to the top of the trochanter. This line is practically Nélaton's. The second line will be found diminished on the damaged or diseased side" (Morris).

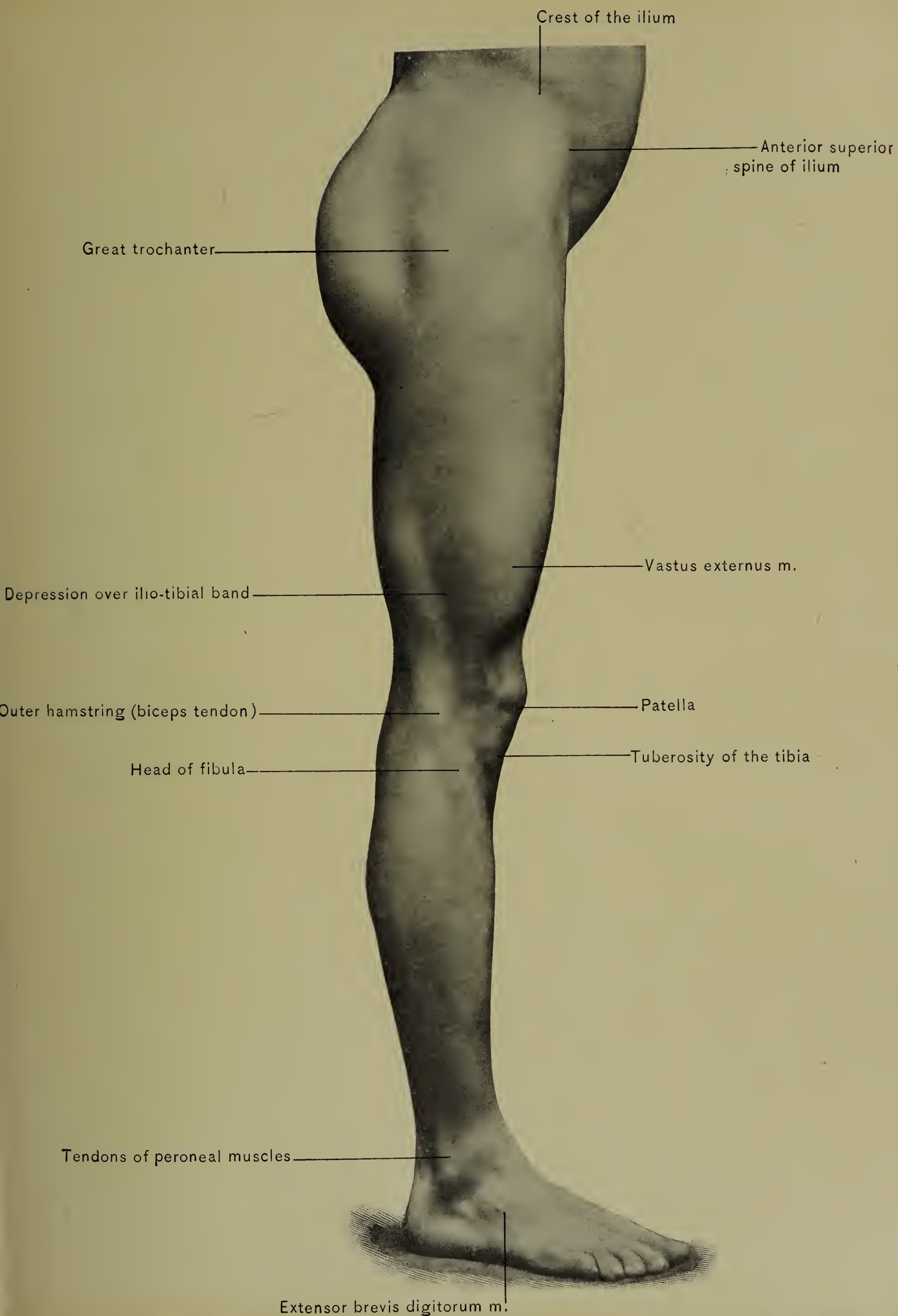
To the outer side of the great trochanter the **tensor fasciæ femoris** can be plainly seen. It extends three or four inches (7.5 to 10.0 centimeters) below the great trochanter, beyond which point the strong ilio-tibial band can be felt. The sar-

sartorius muscle is found immediately internal to the latter. This muscle is one of the most serviceable landmarks of the thigh. It is made quite prominent by spontaneous flexion of the hip and knee in combination with outward rotation of the thigh. It forms the outer boundary of Scarpa's triangle, crosses the femoral vessels about four inches (ten centimeters) below Poupart's ligament, and runs over the roof of Hunter's canal. In the middle line of the thigh in front is the prominence made by the **rectus femoris muscle**, to either side of which are found the **vasti muscles**. During voluntary extension of the knee-joint a depression can be felt between the vastus internus and the adductor muscles, which indicates the location of Hunter's canal. With the knee flexed, the vastus internus muscle forms a prominence to the inner side of and above the knee-joint.

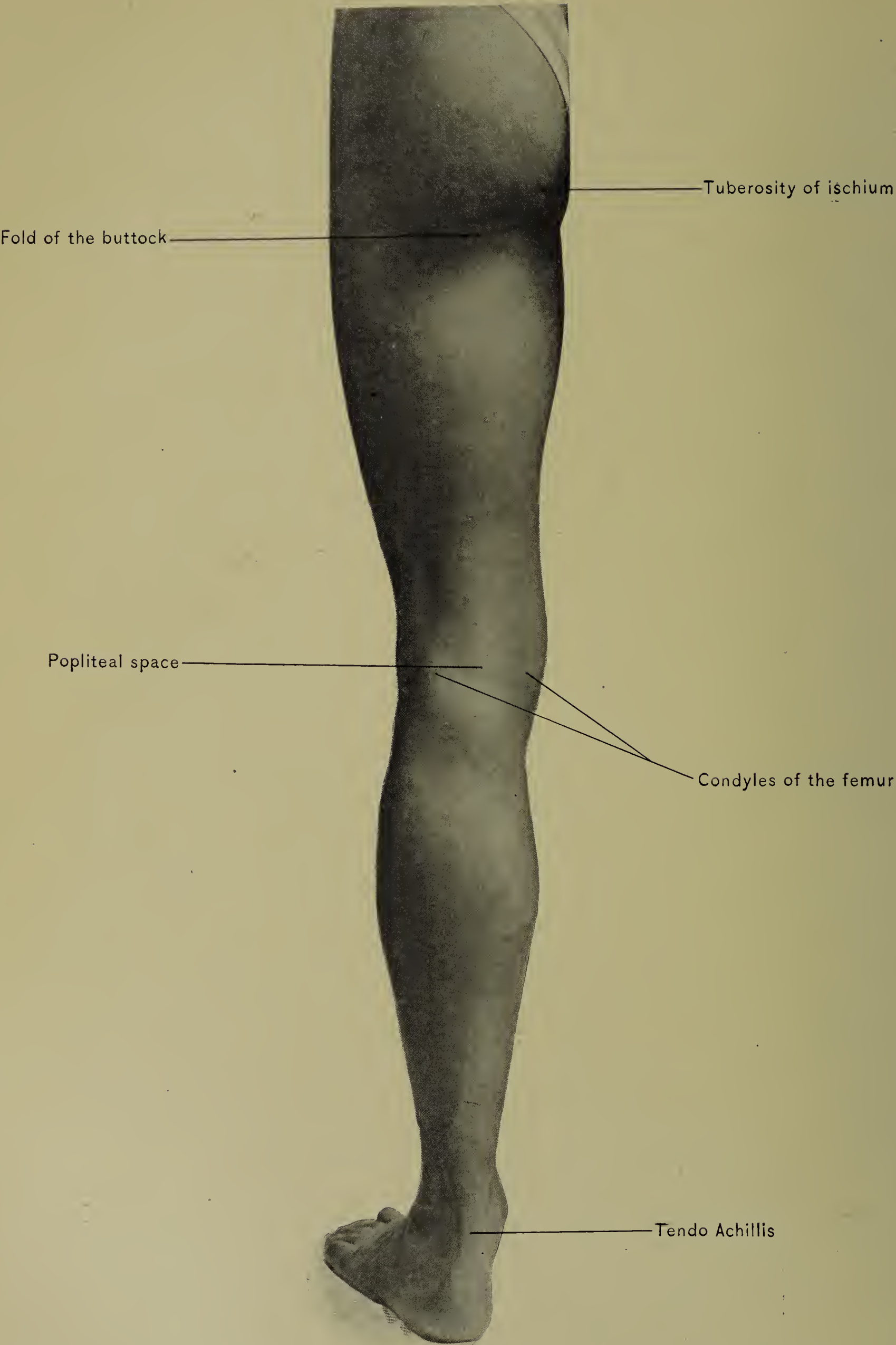
On the anterior aspect of the thigh and below Poupart's ligament is a slight depression which corresponds to **Scarpa's triangle**. The boundaries of the triangle are formed by Poupart's ligament above, the sartorius muscle externally, and the adductor longus internally. The latter muscle becomes prominent by abducting the thigh. Near the base of the triangle are found two rows of lymphatic glands which can often be felt. The triangle is mainly of importance on account of its apex being the point of election for the ligation of the superficial femoral artery.

The **saphenous opening** is about an inch and a half (3.75 centimeters) external to the spine of the pubis, and just below the inner third of Poupart's ligament. It is usually marked by a slight depression in the skin, at which point a femoral hernia first appears. The long saphenous vein passes through it to empty into the common femoral vein. On either side of the opening there are lymphatic glands which may become enlarged and may be confounded with a hernia.

The **femoral ring** is under the inner end of Poupart's ligament; it lies deeper than the saphenous opening, and about half an inch above it. Its plane faces downward, and is thus at right angles to the plane of the saphenous opening which faces forward. A femoral hernia passes downward through the femoral ring, forward through the saphenous opening, skirting the lower margin of the superior falciform process (Hey's ligament), and then upward over Poupart's ligament. In the reduction of a femoral hernia it is therefore necessary to first draw it downward to the saphenous opening, then to push it backward beyond the lower edge of the superior falciform process, and upward through the femoral ring into the abdominal cavity. Holden's rule for finding the femoral ring is to locate the femoral artery, by its pulsations, as it crosses the horizontal ramus of the pubis; then allow a half inch (1.25 centimeters) on its inner side for the femoral vein, beyond which is the femoral ring. The course of the **common** and **superficial femoral**



SURFACE MARKINGS OF OUTER ASPECT OF LOWER EXTREMITY.



SURFACE MARKINGS OF POSTERIOR ASPECT OF LOWER EXTREMITY.

arteries is indicated by the upper two-thirds of a line drawn from a point midway between the anterior superior spine of the ilium and the spine of the pubis to the adductor tubercle. The point of election for the ligation of the superficial femoral artery is at the apex of Scarpa's triangle. This point is chosen because it is readily determined by using the sartorius as a guide, because the vein lies behind the artery at this point, and because of its distance from the origin of the profunda femoris. Compression of the common femoral artery is best accomplished by pressure downward and a little backward (the patient being on his back) at a point about midway between the anterior superior spine of the ilium and the spine of the pubis. The artery is easily recognized by its strong pulsations.

The Buttocks.—The distinct **bony landmarks of the buttocks** are: (1) The posterior superior iliac spines, which are on the same level as the second sacral spine and the middle of the sacro-iliac joint; (2) the sacral spines, of which the third marks the lowest level of the spinal meninges and inclosed fluid; (3) the two tubercles of the last sacral vertebra; (4) the base of the coccyx, from which a cutaneous furrow runs to the anus, and sometimes forms a dimple; and, (5) the tuberosities of the ischia, on either side of the anus, which mark the lateral boundaries of the perineum. The tuberosities of the ischium are covered by muscles and fat in the erect attitude, but only by fat and a bursa in the sitting posture. A prominent buttock, not due to disease, is an index of vigorous health; it is composed of the gluteal muscles liberally covered by fat. Inequality in the size of the buttocks may indicate hip-joint disease.

The **fold of the buttock** is the crease formed by the skin, fat, and fascia overhanging the back of the thigh; it is said to mark the lower edge of the gluteus maximus muscle, but this is manifestly incorrect, since the furrow crosses the outer portion of that muscle; and at its inner end is below the origin of the muscle. Pressure can be made in this fold, between the tuberosity of the ischium and the great trochanter, but nearer the former, on the great sciatic nerve; this is proved by the succeeding numbness of the area of distribution of the nerve if the pressure be continued. Continuous tension due to extreme flexion of the hip causes benumbing of the nerve. Pressure upon the nerve at the back of the thigh while in the sitting posture also often produces numbness. This fold becomes less prominent in hip-joint disease.

The **gluteal artery** emerges from the pelvis at a point opposite the union of the inner with the middle third of a line extending from the posterior superior spine of the ilium to the top of the great trochanter when the thigh is rotated inward. The sciatic artery emerges about a half inch (1.25 centimeters) below the gluteal.

The **internal pudic artery**, as it crosses the spine of the ischium in its

passage from the greater to the lesser sacro-sciatic foramina, is indicated by the junction of the middle and lower thirds of a line drawn from the posterior superior spine of the ilium to the tuberosity of the ischium. It can be felt pulsating at that point in thin subjects and can be compressed there in hemorrhage from this vessel. The **sciatic artery** is close to it, but on its outer side.

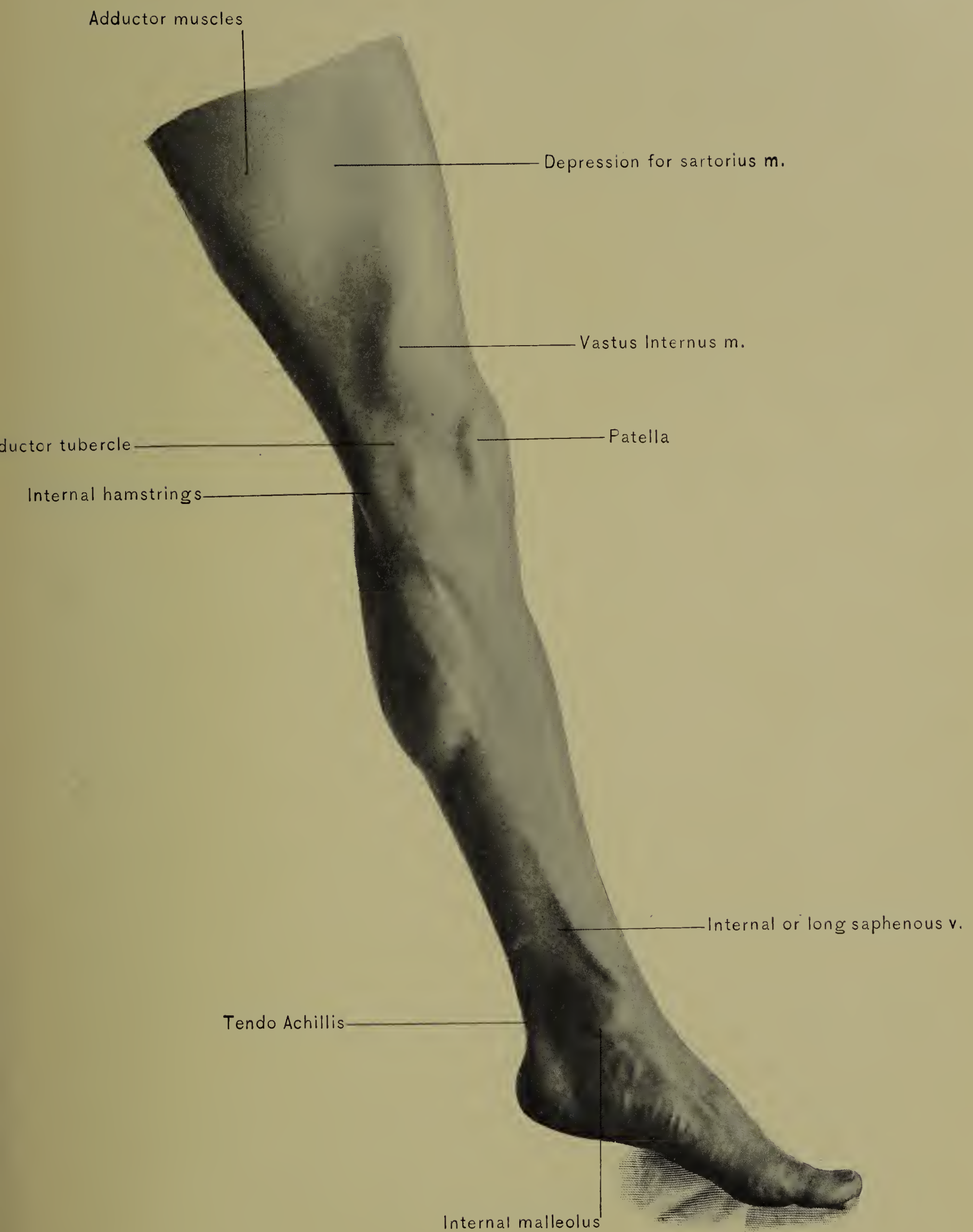
Holden remarks in this connection that sitting upon hard seats puts the weight of the superimposed body upon the tuberosities of the ischium, while soft seats and cushions bear upon the soft parts also, and impede the circulation through the extra-pelvic vessels, thus tending to intra-pelvic congestion and ailments.

The Knee.—The **bony points** about the knee are the patella, the condyles of the femur, the tubercle of the tibia, the tuberosities of the tibia, the head of the fibula, and the adductor tubercle.

The patella.—With the extensor muscles relaxed, the patella can be readily moved from side to side, and its borders distinctly felt. The internal border is a little more prominent than the external. Numerous sulci may be felt on the anterior surface of the bone, into which tendinous bundles from the tendon of the rectus femoris muscle are inserted. MacEwen has pointed out the fact that these fibers are liable to become caught between the ends of the fractured patella and thus prevent bony union. Although the patella articulates with the femur, yet it has no definite fixed relation to that bone. In extension of the leg the patella rides upward in front of the condyles of the femur, and in extreme extension only the lower part of the patella is in contact with the bone, the upper portion lying on the bed of fat which covers the lower part of the femur. In flexion of the leg, the relative position of the patella changes with the degree of flexion. Thus, in semiflexion the middle third of the patella rests upon the most prominent part of the condyles. This position is considered the one in which the patella is most liable to be fractured by muscular force, as the strain of the quadriceps extensor femoris muscle is at right angles to the long axis of the bone. In extreme flexion the bone recedes into the groove between the condyles. In this position only the upper third rests upon the femur, the remainder lying on the cushion of fat between it and the tibia.

With the leg extended, the condyles of the femur can be readily felt on either side of the patella. The inner one is generally more prominent. The tubercle of the tibia is felt in front of the upper extremity of the tibia, in line with the tendon of the patella.

The **head of the fibula** rests upon the outer back part of the tibia on about the level of the tubercle of the tibia. The peroneal nerve crosses the fibula just below its head, and is sometimes compressed in thin persons when the legs are crossed, causing numbness and tingling along its course.



SURFACE MARKINGS OF INTERNAL ASPECT OF LOWER EXTREMITY..

The **adductor tubercle**, upon the base of the inner condyle, gives attachment to the tendon of the adductor magnus, and marks the position of the epiphyseal line of the lower end of the femur, and the highest part of the trochlea for the patella—points useful to remember in knee excision. One-half inch (1.25 centimeters) above this point the femur is divided in the operation of osteotomy for the correction of knock-knee.

The tuberosities of the tibia are an external and an internal.

The **external tuberosity**, upon the outer side of the head of the bone, has attached to it the lower end of the lateral band of the fascia lata (*ilio-tibial band*), by some described as a tibial insertion of the tensor fasciæ femoris. It also indicates the lowest level of the synovial sac of the knee. The **internal tuberosity** is not so prominent as the external. Between the internal tuberosity and the internal condyle of the femur is a depression in which can be felt a dislocated internal semilunar fibro-cartilage.

The **tendo patellæ** is in relation behind in its upper half with the synovial sac of the knee-joint, and in its lower half with a pad of fat. It is vertical in position and should be in line with the tibial tubercle and middle of the ankle in a well-formed leg, a point to be remembered in setting fractures, especially if they are double or comminuted.

The **synovial membrane** of the knee projects upward fully two inches (5.0 centimeters) above the patella when the knee is extended; laterally it extends further upward under the vastus internus than it does under the vastus externus. In bending the knee the tubercle of the tibia is carried away from the front of the condyles of the femur, drawing with it the tendo patellæ and the patella, which in turn draws the upper pouch of the synovial sac downward, so that this does not extend as high up on the femur when the knee is flexed as it does when the joint is extended. It is for this reason that the knee is flexed in operations upon the lower end of the femur. The lower limit of the synovial sac of the knee-joint is at the top of the tibia.

The **popliteal** (diamond-shaped) **space** is seen as a depression behind the knee. It is bounded externally and above by the outer hamstring tendon, the biceps; internally and above by the inner hamstring tendons, which are, from within outward, the semitendinosus, the semimembranosus, and the gracilis. The sartorius skirts the inner back part of the knee, giving it a graceful swell. The lower boundaries, the two heads of the gastrocnemius, are not distinctly perceptible on the surface. With the knee extended, the contents of the popliteal space form a longitudinal ridge in the median line.

The **popliteal artery** lies deeply in the middle line of the popliteal space upon the back of the lower end of the femur, the posterior ligament of the knee-

joint, and the popliteus muscle. The guide to it is the outer margin of the semi-membranosus. It is overlaid by the internal popliteal nerve and the popliteal vein, the nerve being the more superficial.

The **peroneal nerve** can be felt in thin people on the inner side of the tendon of the biceps. Care should be exercised not to cut it in tenotomy of the biceps.

The Leg and Ankle.—Besides the tubercle of the tibia, the leg is marked in front by the sharp edge of the tibia, or **shin**, by a smooth subcutaneous surface of the same, and to a certain extent by its inner edge, which is not so well defined. The lower third of the tibia is the narrowest part and most subject to fracture.

The **fibula** is almost buried by the peroneal muscles, and is subcutaneous in its lower fourth only, where fractures occur frequently. It lies on a plane posterior to that of the tibia, a point to be remembered in amputation by the flap method. It is arched backward.

Upon the front of the upper two-thirds of the leg, when the ankle is voluntarily and strongly flexed, a firm elevation appears between the two bones due to the contraction of the anterior tibial and the extensor muscles of the toes. This is a point of soreness in athletes who begin training for a walking match, because of the strain upon the muscles in keeping the toes off the ground in the descent of the foot at each long stride.

The **malleoli** are the great landmarks of the ankle, the outer descending lower than the inner. The inner is the wider and extends further forward than the outer, but is on the same plane with it behind. Holden appropriately likens the shape of the outer malleolus to a serpent's head. In a well-formed leg the inner malleolus is in a line with the inner border of the patella and the inner side of the head of the metatarsal bone of the great toe. This rule is useful in the setting of fractures which disturb these relations.

Behind the ankle is the prominent **tendo Achillis**, which is narrowest at about the level of the inner malleolus, where it is preferably cut in tenotomy. It bends slightly forward and is held in that position by a thickened portion of the deep fascia attached to the tibia and fibula. This portion of the deep fascia might be considered a posterior annular ligament. On either side of the tendon, between it and the malleoli, are two distinct depressions.

The **tendon of the tibialis posticus** lies close to the back of the tibia, upon the inner side of the angle. It is invested by a synovial sheath, from its insertion into the tubercle of the scaphoid to an inch and a half (3.75 centimeters) above the apex of the internal malleolus. In tenotomy it should, therefore, be cut about two inches (5.0 centimeters) above the apex of the malleolus, so as to avoid the sheath. The guide to this tendon is the inner edge of the tibia, but in a fat leg this will not answer; it is then advisable to cut exactly midway between the front

and back of the leg, a little in front of this point being the internal saphenous vein and a little behind it the posterior tibial artery.

The **peroneal tendons** pass behind the outer malleolus, and in tenotomy should be severed about two inches (5.0 centimeters) above the tip of the malleolus so as to avoid their synovial sheaths.

The **tendon of the tibialis anticus** (in tenotomy) should be cut about one inch (2.5 centimeters) above its insertion into the internal cuneiform bone, to avoid the lower end of its synovial sheath, the knife being inserted on its outer side to avoid the dorsalis pedis artery.

The other tendons upon the front of the ankle are those of the extensor proprius hallucis and extensor longus digitorum, being external to the tendon of the tibialis anticus in the order named.

The **extensor brevis digitorum** is very evident upon the outer side of the instep as a firm elevation when the toes are forcibly extended. Its external margin is just in front of the groove on the outer side of the os calcis which transmits the tendon of the peroneus brevis.

The Course of the Arteries and Veins of the Leg.—The popliteal artery divides about one inch (2.5 centimeters) below the tubercle of the tibia into the anterior and posterior tibial, the latter giving off the peroneal about two inches (5.0 centimeters) further down. Therefore, suggests Holden, one main artery is severed in an amputation one inch (2.5 centimeters) below the fibular head (the popliteal); two arteries in amputations two inches (5.0 centimeters) below the fibular head (the anterior and posterior tibials); and three arteries in amputations three inches (7.5 centimeters) below the head of the fibula (the two tibials and the peroneal). The **anterior tibial**, after coming forward between the two bones, lies in front of the interosseous membrane near the fibula. Its course down the leg is marked by a line drawn from a point midway between the head of the fibula and the tubercle of the tibia to the middle of the front of the ankle, which line also indicates, quite accurately, the outer border of the tibialis anticus throughout its length. The pulsations of the artery are readily distinguished as it crosses the front of the lower end of the tibia and the ankle. The **posterior tibial** in its course down the leg corresponds to a line extending from the middle of the upper part of the calf to the center of the fossa behind the inner ankle, where its pulsations are readily felt about a half inch (1.25 centimeters) back of the tibial border. In the upper part of its course the vessel is reached through an incision carried parallel with and half an inch (1.25 centimeters) posterior to the inner border of the tibia.

The Foot.—The **veins of the foot** form an arch across the metatarsus, with its convexity toward the toes. From the inner extremity of the arch arises the

internal or *long saphenous vein* which passes upward in front of the inner malleolus, thence up the inner side of the leg, behind the inner condyle of the femur, and along the inner side of the thigh, gradually moving forward in its ascent upon the thigh to enter the common femoral vein through the saphenous opening. From the outer extremity of the arch arises the *short* or *external saphenous vein*, which passes behind the outer malleolus, and up the middle of the back of the leg to enter (as a rule) the popliteal vein.

The **bony landmarks of the foot** on the inner side, going forward, are : (1) The inner tuberosity of the os calcis ; (2) the internal malleolus ; (3) one inch (2.5 centimeters) below the malleolus, the sustentaculum tali, for the support of the astragalus ; (4) the tubercle of the scaphoid, about one inch (2.5 centimeters) in front of and a little below the inner malleolus, the gap between it and the sustentaculum tali being occupied by the calcaneo-scaphoid ligament and posterior tibial tendon which sometimes contains a sesamoid bone ; (5) the internal cuneiform ; and (6) the prominence of the base of the first metatarsal bone. In the same order, externally, we find : (1) The external tuberosity of the os calcis ; (2) the outer malleolus ; (3) the tubercle on the peroneal ridge of the os calcis, one inch (2.5 centimeters) below the outer malleolus, with the short peroneal tendon above and the long one below it ; and (4) the prominence of the base of the fifth metatarsal bone.

The **guides to the joints of the foot** are as follows : In *Symes' amputation* of the foot it is to be remembered that the ankle-joint is found a half inch (1.25 centimeters) above the tip of the inner malleolus. In *Chopart's amputation* a line carried transversely across the tarsus and behind the tubercle of the scaphoid will locate the astragalo-scaphoid and calcaneo-cuboid joints. The latter joint is also found on the outer side of the foot midway between the tip of the outer malleolus and the base of the last metatarsal bone. In *Lisfranc's operation* (removal of the metatarsus) the *metatarso-cuneiform joint* is situated an inch and a half (3.75 centimeters) in front of the tubercle of the scaphoid, and the *metatarso-cuboid joint* is just behind the large tubercle upon the base of the fifth metatarsal bone. The line of the metatarso-phalangeal joints is fully one inch (2.5 centimeters) to the proximal side of the interdigital folds of skin, a fact to be remembered in cutting off toes.

The **dorsalis pedis artery** can be felt beating upon the instep on a line drawn from the middle of the ankle to the proximal end of the first interosseous space, along the outer side of the tendon of the extensor proprius hallucis.

The **plantar arteries** arise at the inner border of the sole of the foot, whence they pass forward ; the *external plantar artery* runs obliquely outward across the foot in a line drawn from a point midway between the internal malleolus and the

great tuberosity of the os calcis to the base of the fifth metatarsal bone, thence turning obliquely inward and forward across the foot near the bases of the metatarsal bones, to join the communicating branch of the dorsalis pedis artery in the first interosseous space. The *internal plantar artery* runs along a line drawn from the inner side of the os calcis to the middle of the great toe.

The **plantar fascia** is divided to best advantage and with least trouble at its narrowest part, about one inch (2.5 centimeters) in front of its connection with the os calcis. This brings the incision behind the plantar arteries, the knife being introduced at the inner side of the foot.

The **tendon of the adductor hallucis** may be severed subcutaneously about one inch (2.5 centimeters) back of its insertion into the inner side of the base of the first phalanx.

The arches of the foot will be fully considered under the anatomy and surgery of this part.

THE FRONT OF THE THIGH.

The body should be placed on its back with a block beneath the loins and the thigh abducted and rotated outward to make evident the hollow at its upper and anterior part.

The skin over the upper, anterior, and inner part of the thigh is comparatively thin and delicate. The looseness of its attachment to the parts beneath permits of its being greatly stretched, except along the groove corresponding to the external intermuscular septum of deep fascia which separates the vastus externus from the outer hamstring muscle, in which situation it is a little more adherent. This laxity is well demonstrated in cases of large herniæ and tumors of large size, and is of advantage surgically in that it favors the performance of circular amputation in this region. In the vicinity of the pubes are numerous sebaceous and sudoriferous glands, the secretion of which favors the development of the intertrigo in the fold of the groin so often seen in infants and in corpulent individuals.

A few instances of a supernumerary mammary gland in the integument of Scarpa's triangle are on record. After deep and severe burns of this neighborhood the resulting scars may contract to such an extent as to produce a permanent flexing of the thigh. Wounds of the groin, if transverse, can be approximated by flexion of the thigh.

DISSECTION.—From a point about three inches (7.5 centimeters) behind the anterior superior spine of the ilium carry an incision over the crest of the ilium and along the line of Poupart's ligament to the spine of the pubis, thence along the crease between the scrotum and thigh, and from there downward along the

inner side of the thigh to a point two inches (5.0 centimeters) above the knee; beginning at the latter point the incision is to be carried transversely across the front of the thigh. Turn the skin outward in one large flap. To study the structures around the knee, incise the skin transversely three inches (7.5 centimeters) below the patella, across the anterior half of the leg, and connect the inner ends of this and the one above the patella by a longitudinal incision and reflect this flap of skin outward.

The **superficial fascia** of the anterior part of the thigh varies in thickness, nowhere being very dense. It has little or no influence upon the progress of a superficial abscess, as is well illustrated by the readiness with which pus from suppurating glands in Scarpa's triangle reaches the surface. It consists of two layers, between which are situated the superficial lymphatic glands and vessels, and the superficial vessels and nerves. In the lower part of the thigh the two layers practically merge into one, and cannot be separated as in the upper part.

The *superficial layer of the superficial fascia* is continuous with a similar layer of the abdomen, scrotum (dartos), perineum, buttocks, and leg. Fatty tumors are quite commonly met with in Scarpa's triangle. When present, they show a marked tendency to extend downward, the growth of the tumor in that direction being aided by gravity. At times such a growth has extended from the groin almost to the knee. The looseness of the capsule of the tumor and the laxity of the tissue in which it lies favor the extension. The superficial layer is lax and permits of extensive extravasations of fluid or air beneath the skin. As the superficial layer of the superficial fascia of the thigh is continuous with that of the abdomen, emphysema of the former is frequently seen consequent upon the same condition of the abdomen. This layer of fascia is freely movable over the subjacent layer. Owing to its laxity, a fold of integument can be pinched up over a strangulated femoral hernia and transfixed, and thus a linear incision be obtained, which does not include either sac or intestine. It is safer, however, to make a careful dissection down to the hernial sac.

DISSECTION.—The superficial layer of the superficial fascia should now be reflected by incisions similar to those made in reflecting the skin. The superficial vessels and nerves and the lymphatic glands between the two layers form a guide.

The deep layer of the superficial fascia.—This layer, unlike the superficial, is attached to the fascia lata about one inch (1.25 centimeters) below Poupart's ligament. That portion which covers the saphenous opening, to the margins of which it is closely attached, being pierced by numerous small blood and lymphatic vessels, is called *cribriform* (sieve-like) *fascia*; it is carried in advance of a femoral hernia, thus forming one of its coverings.



ABDOMEN,—DEEP LAYER OF SUPERFICIAL FASCIA, SUPERFICIAL EPIGASTRIC, AND CIRCUMFLEX ILIAC VESSELS.



LINES FOR INCISIONS IN DISSECTION.

The superficial blood-vessels.—The vessels occupying the superficial fascia are the superficial epigastric, the superficial external pudic, and the superficial circumflex iliac arteries, branches of the common femoral artery, with their accompanying veins, and the long saphenous vein. The *superficial epigastric* and *superficial external pudic arteries* reach the interval between the layers of the superficial fascia by piercing the cribriform fascia which closes in the saphenous opening; the *superficial circumflex iliac artery* arises either separately or by a common trunk from the common femoral artery, and usually pierces the deep fascia on the outer side of the saphenous opening. The *superficial epigastric artery* passes over Poupart's ligament to the lower part of the abdomen and communicates with branches of the deep epigastric and internal mammary arteries. The *superficial external pudic* and *superficial epigastric arteries* cross the spermatic cord; the former is distributed to the external genitalia and anastomoses with branches of the internal pudic artery, and, as it crosses the cord, with branches of the cremasteric artery. The *superficial circumflex iliac*, the largest of the three branches, passes outward to the crest of the ilium and is distributed to the integument. The accompanying veins of the arteries empty into the long saphenous vein.

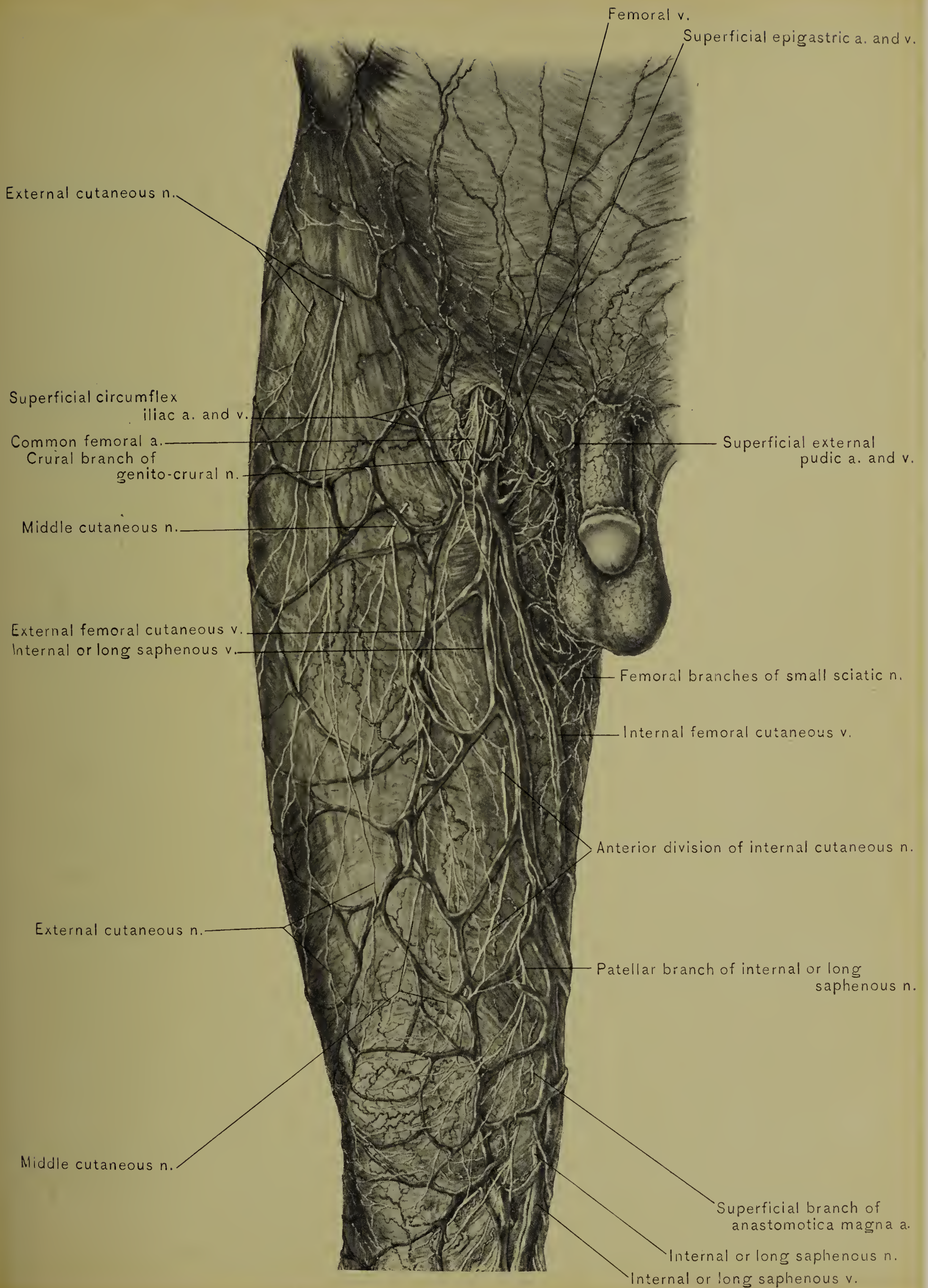
The **superficial inguinal glands**, which can be felt through the skin when enlarged, are exposed in this dissection, and are easily recognized by their oval form and reddish-brown color. They consist of two groups: one, the upper, lies along the line of Poupart's ligament; and the other, the lower, lies along the long saphenous vein and occupies, chiefly, the deep layer of the superficial fascia over the saphenous opening. The upper group receives the lymphatics from the part of the abdominal walls below the umbilicus, from the penis, part of the urethra, the scrotum, the perineum, the buttocks, and the upper and outer aspects of the thigh. The lower group receives the lymphatics from the foot, leg, and thigh. Of the lymphatics from the outer side of the foot and leg, some pass with the short or external saphenous vein and empty into the glands of the popliteal space, while others cross to the long saphenous vein, which the internal group accompanies, and empty into the inguinal glands. The vessels from all these glands reach the abdomen through the femoral ring. Inflammation of these glands constitutes a **bubo**. Enlargement of the group along Poupart's ligament may simulate an incomplete oblique inguinal hernia, hence the name **bubonocoele**; enlargement of the group over the saphenous opening may be mistaken for a femoral hernia. Suppuration of the glands composing the lower group may demand an incision, which should be made with care owing to the intimate relation which these glands hold to the femoral and long saphenous veins. Thorough removal of these glands, in cases of long-standing

enlargement associated with sinuses and periglandular infiltration, is a delicate operative procedure, and may lead to serious results unless great care is exercised. I recall one case where the interne of a hospital was granted permission to perform this operation and the femoral vein was torn, necessitating amputation of the thigh. Curetting is the safer method of disposing of this condition, and when a sinus is found to lead into the femoral canal, it is to be curetted and drained by the introduction of a short tube or packed with antiseptic gauze. Complete removal of the glands of the groin on both sides of the body may be followed by an extensive and troublesome edema of the external genitalia, especially if the operation is followed by erysipelas or other inflammatory processes.

The **long or internal saphenous vein**, the chief subcutaneous vein of the lower extremity, ascends along the inner and front part of the thigh to a short distance below Poupart's ligament, where it passes through the saphenous opening in the fascia lata to join the common femoral vein. In its course it receives many tributary veins, some of which are often large, especially one which courses around the inner part of the thigh and is frequently as large as the main trunk. Just before its termination the long or internal saphenous vein is joined by the superficial veins accompanying the superficial arteries of the upper part of the thigh and lower part of the abdomen. The veins on the outer side of the thigh sometimes join to form a large trunk, so that occasionally two or three large veins are seen converging toward the saphenous opening. Like nearly all subcutaneous veins, the long saphenous is provided with valves, varying from two to six in number; they are more numerous in the thigh than in the leg, and are situated chiefly at the junctions with the other veins.

Varicose saphenous veins.—A varicose (dilated, tortuous, and thickened) condition of the portion of the long saphenous vein below the knee is frequently seen, while the same condition of the entire vein, though not so common, is occasionally met with. It may result from pressure at the saphenous opening caused by a femoral hernia, enlarged glands, etc., or by pressure upon the inferior vena cava or common iliac veins. Again, it may follow an accident or phlebitis. A varicosity of the long saphenous vein at its entrance into the femoral vein is sometimes encountered, and such a condition has been mistaken for femoral hernia. Although it is sometimes necessary to dissect out the entire saphenous vein on account of its varicose condition, usually the excision of portions of it suffices. Schede, of Hamburg, recommends a circular incision below the knee through skin and superficial fascia, severing all the surface veins, ligating the cut ends above and below, and then closing the circular incision.

The Cutaneous Nerves.—The cutaneous nerves of the thigh are the external



SUBCUTANEOUS VESSELS AND NERVES OF FRONT OF THIGH.

cutaneous, the middle cutaneous, the internal cutaneous, the crural branch of the genito-crural, and the ilio-inguinal nerve.

The **external cutaneous nerve**, a branch of the second and third lumbar nerves, enters the thigh beneath Poupart's ligament close to the anterior superior spine of the ilium; it crosses the origin of the sartorius and divides into two branches—an anterior and a posterior. The *anterior branch*, the larger of the two, lies embedded in the fascia lata, emerges from the fascia about four inches (10.0 centimeters) below the ligament, and descends along the anterior and outer part of the thigh as far as the knee, where it helps to form the patellar plexus, giving off numerous branches. The *posterior branch* pierces the fascia lata about two inches (5.0 centimeters) below the ligament and divides into branches which are distributed to the integument covering the upper and outer part of the thigh.

The **middle cutaneous nerves**, one or two in number, are given off from the anterior crural. One usually pierces the sartorius muscle, while the other crosses it; after piercing the fascia lata about four inches (10.0 centimeters) below Poupart's ligament, they descend along the front and inner part of the thigh as far as the knee, distributing branches on either side, inosculating, below, in the patellar plexus with the long saphenous and internal cutaneous nerves, and, above, with the crural branch of the genito-crural nerve.

The **internal cutaneous nerve**, likewise a branch of the anterior crural, passes obliquely across the sheath of the femoral artery at the apex of Scarpa's triangle, and, after giving off a few cutaneous filaments, divides in front of, or at the inner side of, the femoral artery into two branches—an anterior and a posterior. The *anterior branch*, the larger, runs downward in front of the sartorius and perforates the fascia lata at the lower third of the thigh, where it divides into terminal branches; one of these supplies the integument over the inner side of the knee, and the other crosses the patella to supply the outer side of the knee and to communicate with the long saphenous and obturator nerves. It contributes to the plexus patellæ. A cutaneous branch accompanying the long saphenous vein is sometimes given off from this nerve. The *posterior branch* descends along the posterior border of the sartorius muscle to just above the knee-joint, where it pierces the fascia lata and supplies the integument on the inner side of the leg. It sends filaments to the subsartorial plexus. In cases where the anterior branch of the obturator nerve is very small the inner branch of the internal cutaneous will be found correspondingly large, and vice versâ. It is important to note that at the point of election for the ligation of the femoral artery (the apex of Scarpa's triangle) one (sometimes two) of the branches of the internal cutaneous nerve crosses the sheath of the vessel.

The **patellar plexus**, lying over the anterior aspect of the knee, is formed by the inosculations of the anterior division of the external cutaneous, the middle

cutaneous, the anterior division of the internal cutaneous, and the long saphenous nerve.

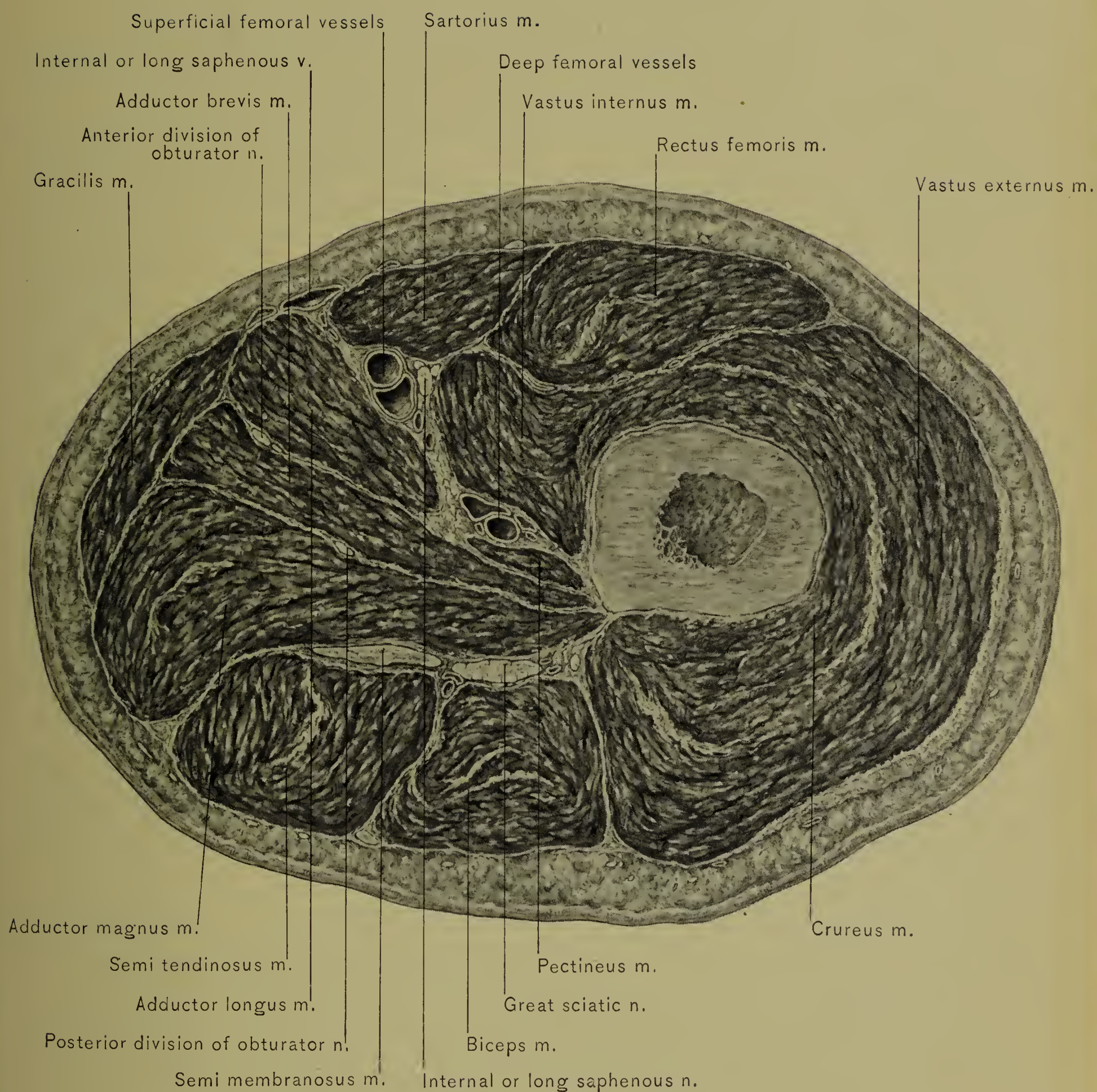
The **subsartorial plexus** is formed beneath the fascia lata and below the adductor longus at the posterior border of the sartorius muscle by branches of the internal cutaneous, long saphenous, and obturator nerves.

The **crural branch of the genito-crural nerve** pierces the anterior wall of the femoral sheath and, immediately below the middle of Poupart's ligament, pierces the fascia lata to supply the integument of the anterior aspect of the thigh, where it communicates with the middle cutaneous nerve; it distributes a few filaments to the femoral artery under Poupart's ligament.

The **ilio-inguinal nerve**, after passing through the external abdominal ring, supplies the skin on the inner and upper aspect of the thigh, a branch also going to the scrotum in the male and to the labium in the female.

DISSECTION.—Remove the deep layer of the superficial fascia by making incisions similar to those made for the removal of the skin. Reflect it outward and the deep fascia will be exposed. In removing that portion of the deep layer of the superficial fascia which closes in the saphenous opening, the cribriform fascia, care must be exercised in order to preserve the margins of that opening to which it is attached. It is also attached to the anterior surface of the sheath of the femoral vessels. Cunningham regards the cribriform fascia as a thin part of the fascia lata, prolonged from the outer margins of the saphenous opening.

The Fascia Lata.—The deep fascia, or fascia lata, one of the most important structures of the body from a surgical standpoint, invests the thigh at all parts. It is attached, above, to the outer lip of the crest of the ilium, Poupart's ligament, the body of the pubis, the rami of the pubis and ischium, the tuberosity of the ischium, the great sacro-sciatic ligament, the sacrum and coccyx, and, behind the femoral vessels, to the capsule of the hip-joint. It is perforated by the superficial circumflex iliac artery; and by the external, middle, and internal cutaneous nerves. It is thickest and strongest on the outer side of the limb, where are inserted into it the tensor fasciæ femoris muscle and two-thirds of the gluteus maximus muscle. This thickened portion of the fascia extends over the great trochanter between the crest of the ilium above, and the outer tuberosity of the tibia and head of the fibula below, and is known as the **ilio-tibial band**. This band of fascia is an important factor in steadying the pelvis and maintaining the extension of the knee-joint when the body is in the erect position. The portion of the ilio-tibial band between the crest of the ilium and the great trochanter becomes relaxed in fracture of the neck of the femur, since the great trochanter approaches nearer the crest of the ilium than normally. The relaxation of the fascia lata at this point Dr. O. H. Allis regards as of value in the diagnosis of intra-capsular fracture of the femur.



INTERMUSCULAR SEPTA.

The fascia is thinnest at the upper and inner aspect of the thigh, where it covers the adductor muscles. It increases considerably in strength as it approaches the front of the knee. At the knee it is attached to the condyles of the femur, the lateral margins of the patella, the inner and outer tuberosities of the tibia, and the head of the fibula, thus forming an aponeurotic expansion which serves to protect and strengthen the knee-joint. Around the knee it receives fibrous expansions from the tendon of the biceps externally, from the sartorius, gracilis, and semitendinosus muscles internally, and from the quadriceps extensor muscles in front. On each side of the thigh it sends in a process which is attached to the whole length of the linea aspera and the condyloid ridges, forming what are called the **external** and **internal inter-muscular partitions** or **septa**; the external, the stronger, separates the vastus externus in front from the biceps muscle behind, and gives partial origin to them; the internal one separates the vastus internus in front from the adductor muscles behind. In this respect the fascia lata resembles the deep fascia of the arm, from which two processes are sent inward to be attached to the condyloid ridges of the humerus. In the thigh, as in the arm, these partitions of fascia divide the limb into two compartments, best seen upon transverse section. These compartments are of much less surgical importance than are those of the arm. Besides the external and internal intermuscular partitions there are numerous smaller processes separating the individual muscles and inclosing them in separate sheaths. One of these processes which separate the adductors from the flexors has been called the **posterior intermuscular septum**.

The three intermuscular septa divide the thigh into three compartments—an anterior, a posterior, and an internal. The *anterior* contains the extensor muscles, the anterior crural nerve and its branches, the common and superficial femoral and part of the profunda femoris arteries, with their corresponding veins; the *posterior*, the flexor muscles and the great sciatic nerve and part of the popliteal vessels and nerves; and the *internal*, the adductor muscles and the obturator vessels and nerves.

The fascia lata resists, especially at its outer part, the growth of tumors, and the intermuscular septa limit deep extravasations of blood. On account of its density and tenseness it often prevents pus from coming directly to the surface, and consequently an abscess beneath it may burrow extensively. A psoas abscess may burrow as far as the knee, and in one case reported by Erichsen it extended down the leg as far as the tendo Achillis, by the side of which it was opened. An abscess caused by disease of the lower end of the femur may burrow upward. In some cases of abscess beneath the fascia lata on the outer side of the thigh, after pus has been evacuated, the abscess is long in healing. In such cases repair may

be hastened by a subcutaneous section of the fascia covering the cavity, thus favoring collapse and approximation of its wall.

In an extravasation, the result of spontaneous rupture of a femoral aneurysm, the blood spreads rapidly in the cellular spaces of the thigh and produces a uniform swelling of the integument from the groin to the knee. Such a collection has been opened, with the unexpected result of fluid arterial blood escaping from the puncture instead of pus. Richet, who dissected the thigh of a subject in which the condition described above had been detected during life, found that the blood had not only infiltrated the muscular interspaces and the cellular tissue, but even the muscular substance itself; yet in spite of the enormous pressure which must have been brought to bear to effect such a result, the fascia remained intact. I have recently seen a large swelling of the upper two-thirds of the inner aspect of the thigh the result of hemorrhage from the obturator artery, as demonstrated by autopsy, which simulated an abscess to the extent of presenting all the main symptoms found in such a condition. Contraction of the fascia lata after hip-joint disease, paraplegia, infantile paralysis, etc., may call for division, either of the fascia alone or together with the contracted tendons. The fascia has occasionally been ruptured by violence, and through the rent so formed the subjacent muscle has bulged, forming what is known as **hernia of the muscle**. The latter condition involving the quadriceps extensor and adductor longus muscles has been seen.

Pubic and iliac portions of the fascia lata.—The fascia lata covering the upper part of the thigh in front is described as consisting of two portions. The outer portion is known as the *iliac* or *sartorial portion*; the inner, as the *pubic* or *pectineal portion*. Between the iliac and pubic portions is the saphenous opening, through which pass the long saphenous vein, to enter the common femoral, lymphatic vessels, and the superficial epigastric and superficial external pudic vessels. In addition to this large opening in the fascia lata, there are numerous small ones through which pass cutaneous nerves and vessels.

The **saphenous opening**, or **external femoral ring**, is oval in shape and measures about an inch and a half (3.75 centimeters) in length and half an inch (1.25 centimeters) in width. It is situated immediately below Poupart's ligament at the upper and inner part of the thigh between the iliac and pubic portions of the fascia lata. It is covered by the cribriform fascia (that portion of the deep layer of the superficial fascia in relation with the opening), which blends with its margins. Its outer margin, formed by the iliac or the sartorial portion of the fascia lata, is of a semilunar form, thin, strong, and sharply defined, and lies on a plane anterior to the femoral vessels. Above, this margin will be seen as a curved process, the superior cornu, or falciform process, which ascends in front of the femoral vessels, to the sheath of which it is attached by fibrous bands, and becomes

continuous with Gimbernat's ligament. The point of junction between the superior falciform process and the base of Gimbernat's ligament is known as Hey's ligament, and is frequently the seat of stricture in a strangulated femoral hernia. Following the outer margin downward, it will be seen to be continuous below with a well-defined border, the concavity of which is directed upward; this, the inferior cornu of the saphenous opening, lies beneath the long saphenous vein and blends with the pectineal (pubic) portion of the fascia lata. The inner margin of the opening is on a plane posterior to the outer, and behind the level of the femoral vessels; it is less important and not so well defined as the outer margin. The tension of the superior cornu is greatly influenced by the position of the limb. Extension, abduction, and external rotation of the thigh make the cornu very tense, whereas flexion, adduction, and internal rotation render it lax. Therefore the latter is the position in which the limb should be placed before attempting the reduction of a femoral hernia.

DISSECTION.—The fascia lata is now to be removed from the front of the thigh in the same manner as was the skin and superficial fascia and reflected outward as far as the ilio-tibial band of fascia. This necessitates cutting the internal inter-muscular septum. Do not sever the nerves which pierce the fascia. This will expose, on the inner side of the thigh, the adductor muscles; in front, the sartorius and the quadriceps extensor femoris muscles; above and to the outer side, the tensor fasciæ femoris and rectus femoris muscles, and the intermuscular space known as Scarpa's triangle and such of its contents as are superficial.

Boundaries of Scarpa's triangle.—Scarpa's triangle is bounded above by Poupart's ligament, externally by the sartorius muscle, and internally by the adductor longus muscle. The base is directed upward and the apex downward, the latter being formed by the sartorius crossing the adductor longus at the junction of the upper with the middle third of the thigh. The floor of the triangle slopes backward from each side toward the middle, and is formed from without inward by the iliacus and psoas, the pectineus, and the adductor longus, with sometimes a small portion of the adductor brevis between and beneath the last two muscles mentioned. The roof is formed by the fascia lata and the cribriform fascia.

Contents of Scarpa's triangle.—This triangle contains the following structures: The common femoral artery with its two terminal divisions, the superficial and deep femoral; the common femoral vein and the two veins which form it, the superficial and deep femoral; the terminal portion of the long saphenous vein; the origins of the superficial epigastric, superficial external pudic, and superficial circumflex iliac, and the deep external pudic arteries; branches of the common femoral artery; the external and internal circumflex branches of the deep femoral

artery with their veins; the external cutaneous nerve; the anterior crural nerve and its divisions, especially the long saphenous nerve; the crural branch of the genito-crural nerve; and the accessory obturator nerve when present.

The structures which pass under Poupart's ligament, or the crural arch, given in order from the anterior superior spine of the ilium inward, are: the external cutaneous nerve close to the anterior superior iliac spine; the iliacus muscle; the anterior crural nerve; the psoas muscle; the crural branch of the genito-crural nerve; the common femoral artery; the common femoral vein; and lymphatics occupying the three compartments of the femoral sheath; and the accessory obturator nerve when present.

RELATIONS.—Before dissecting further, the femoral sheath having already been opened, the relations of those contents of Scarpa's triangle which are seen upon superficial inspection should be carefully noted. The femoral vessels, surrounded by their sheath, will be seen to occupy the hollow of the triangular space a little to the outer side of the center, with the vein to the inner side of the artery. The long saphenous vein pierces the sheath to enter the common femoral vein, the crural branch of the genito-crural nerve pierces the anterior wall of the sheath, and the anterior crural nerve lies to the outer side of the artery in the groove between the iliacus and the psoas magnus muscles. The long saphenous nerve and the nerve to the vastus internus muscle, both branches of the anterior crural nerve, are seen lying to the outer side of the artery. At the apex of the space the artery is crossed by the sartorius muscle and by the internal cutaneous branch of the anterior crural nerve. At the upper and outer angle of the space is seen the external cutaneous nerve.

Surgical importance of Scarpa's triangle.—Scarpa's triangle is important anatomically on account of the important structures contained therein, and surgically for many reasons; some of which are, that its apex is the point of election for the ligation of the superficial femoral artery; that in this triangle digital pressure is applied to the superficial femoral artery for the cure of popliteal aneurysm; that here the tourniquet is applied to the femoral artery in amputation of the limb below; and that a psoas abscess usually points and a femoral hernia appears in the upper part of the triangle.

The Femoral Sheath.—Situated immediately beneath the saphenous opening and its outer margin are the common femoral artery and vein, surrounded by their sheath. The anterior portion of the femoral sheath is formed by the extension downward of the transversalis fascia beneath Poupart's ligament. The posterior portion is formed by a part of the iliac fascia which reaches the thigh in the same manner as does the transversalis, but passes behind the vessels and in front of the psoas and iliacus muscles. These fasciæ are continuous with each other on the



Femoral v.
Falciform ligament
Femoral a.

Lymphatic gland in femoral canal

Internal or long saphenous v.

Femoral sheath laid open, showing the three compartments

SAPHENOUS OPENING, FEMORAL CANAL, AND COMPARTMENTS OF FEMORAL SHEATH.

outer side of the artery and on the inner side of the vein. The transversalis fascia just beneath Poupart's ligament, where it enters into the anterior wall of the femoral sheath, is considerably thickened, and constitutes what is known as the deep crural arch, as distinguished from the crural arch, or Poupart's ligament. The anterior and posterior walls of the femoral sheath are connected by two vertical septa, which divide the sheath into three separate compartments. The outer septum separates the common femoral artery from the vein; the inner, the vein from the femoral or crural canal. The outer compartment is occupied by the common femoral artery; the middle by the femoral vein; and the inner by a lymphatic gland, a few lymphatic vessels, and a small amount of connective tissue. The anterior wall of the sheath is pierced by the crural branch of the genito-crural nerve, the superficial circumflex iliac, superficial epigastric, superficial external pudic vessels, the long saphenous vein, and lymphatic vessels.

DISSECTION.—To expose the contents and compartments of the femoral sheath it should be opened by carrying an incision across the front of it, when a trap-door flap consisting of the anterior wall can be raised.

The Femoral Canal.—The inner compartment is known as the femoral or crural canal, and is the space between the inner septum and the inner wall of the femoral sheath. It is funnel-shaped, with its apex below, from one-half (1.25 centimeters) to three-fourths (1.9 centimeters) of an inch in length, and extends from the femoral or crural ring to the upper margin of the saphenous opening. It communicates with the abdominal cavity through the femoral or crural ring. In the normal condition the internal compartment of the femoral sheath does not really exist, as the inner wall of the sheath is in almost absolute contact with the septum upon the inner side of the common femoral vein, there being but little connective tissue, a lymphatic gland, and a few lymphatic vessels intervening. These lymphatic vessels connect the femoral and the lower group of the inguinal lymphatic glands with the external iliac glands. To establish the canal, therefore, requires that the inner wall of the sheath be separated from the inner septum by dissection, or by pressure from within. Abnormally the canal may give passage to a loop of intestine, a piece of omentum, or both, constituting a femoral hernia. In a few instances the testicle has been known to pass through it, and the author has found the fimbriated extremity of the Fallopian tube constituting the contents of the sac in a case of strangulated femoral hernia. The course pursued by a protrusion passing out of the abdomen by way of the femoral ring would be first through the ring, thence through the canal, and lastly through the saphenous opening, carrying in advance of it the anterior wall of the femoral sheath. The reasons that the protrusion passes through the saphenous opening are that the canal terminates at the upper margin of the

opening, that the sheath is firmly adherent to the lower and outer margins of the opening, and that it is guided forward by the lymphatic vessels which pass through the opening.

The femoral or crural ring is oval in shape with a transverse diameter of about one-half inch (1.25 centimeters). It is larger in the female than in the male, and hence femoral hernia is more common in the former sex. The fact that Gimbernat's ligament is less firm in the female and its occasional absence also serve to explain the greater frequency of femoral hernia in women. The femoral ring is bounded above by Poupart's ligament and the deep crural arch; below by the horizontal ramus of the pubis, covered by the pectineus muscle and the pectineal portion of the fascia lata; internally by the outer concave margin or base of Gimbernat's ligament and the conjoined tendon; and externally by the inner of the two vertical septa of the femoral sheath and by the common femoral vein. This opening is closed by the so-called septum crurale, derived from the subperitoneal layer of fat which stretches across the ring and extends into the canal; through this covering a few small lymphatic vessels pass on their way to the external iliac glands. To obtain the best possible idea of the femoral ring, when dissecting the abdomen pass the finger along the inner side of the external iliac vein and into the ring, when its boundaries can be distinctly felt. Note particularly the tenseness of the inner, and yielding quality of the outer margin.

Femoral Hernia.—The saphenous opening being the passageway by which a femoral hernia, after having traversed the femoral canal, reaches the thigh, it may be called the external femoral or external crural ring, in contradistinction to the internal femoral or crural ring, or ring proper. A hernia which makes its escape from the abdomen through the femoral ring is either complete or incomplete, according to whether it passes into the canal and remains there or makes its exit from the canal through the saphenous opening. It is the incomplete variety of femoral hernia which, when strangulated, is the more dangerous. This is true, first, for the general reason that in strangulated herniæ the severity of the symptoms is disproportionate to the size of the hernia, and therefore grave symptoms usually occur earlier and are more pronounced in small than in large herniæ; and, second, that not occasioning so marked a swelling as does the complete variety, it is much more likely to be overlooked. The direction taken by an incomplete femoral hernia is directly downward, while that of a complete hernia is downward, forward, and upward. In making the turn upward the hernia is brought over the line of Poupart's ligament, and therefore, from its position, may simulate an inguinal hernia. The spine of the pubis is the landmark by which they can be differentiated. Femoral herniæ are always acquired, differing

in this respect from inguinal and some other forms of hernia which may be congenital.

The **coverings of a femoral hernia** are skin, superficial fascia, cribriform fascia, sheath of the vessels, septum crurale (subperitoneal fat), and peritoneum, the last-mentioned forming the innermost covering or sac of every hernia. What has been said regarding the difficulty in recognizing the different coverings when operating for strangulated inguinal hernia holds good in femoral; in non-strangulated hernia the coverings are usually recognizable.

The **Fascia Propria** of Sir A. Cooper, which is sometimes given as one of the coverings of a femoral hernia, is another name for the thickened portion of the subperitoneal layer of fat mentioned above as the septum crurale and matted together with the anterior wall of the femoral sheath. It may assume a membranous appearance from the pressure of the hernia. It is of importance, since its membranous appearance might cause it to be mistaken by the inexperienced surgeon for the peritoneum; it has not the arborescent arrangement of the vessels seen in the latter. When incised, the fatty portion is exposed; this might be mistaken for omentum, and would still further puzzle the inexperienced.

The relief of constriction in femoral hernia.—The seat of constriction in a strangulated femoral hernia is either Hey's ligament, Poupart's ligament, or the neck of the sac. In dividing any one of these, the following relations should be recalled—namely, that the spermatic cord or the round ligament lies immediately above the upper boundary of the femoral ring, that the deep epigastric artery lies along its upper and outer border, that the pubic branch of the deep epigastric passes round its upper and inner margins. In thirty-seven cases out of one hundred and one collected by Quain, the obturator artery arose from the deep epigastric, and to reach the obturator foramen passed along the outer margin of the ring, while in ten cases it passed above the ring and along its inner margin. Again, when the obturator artery lies to the inner side of the ring it is accompanied by the pubic vein on its way to the external iliac vein. The incision for the relief of the constriction should be made upward and slightly inward to avoid the common femoral vein and the deep epigastric artery. To avoid hemorrhage, of which several fatal cases have been recorded, the hernia knife ought not to be sharp. If the constriction be in the neck of the sac, it should be relieved after the sac has been opened. It is safer to open the sac in every case of strangulated hernia, if for no other purpose than to inspect the contents.

Taxis in femoral hernia.—For the successful reduction of a femoral hernia by taxis, the thigh should be flexed and rotated slightly inward, thus relaxing the upper and outer margins of the saphenous opening. As the hernia, if complete, will present along, if not over, Poupart's ligament, it should first be carried down-

ward to the saphenous opening, pushed backward through the opening, and then upward through the femoral canal. By this manipulation the contents of the rupture are made to take a course the reverse of that by which they reached the thigh. It is proper to state here that the sac of the hernia is not reducible unless it be of very recent origin, before sufficient time has elapsed for the formation of adhesions.

The **Sartorius**, a narrow, flat muscle, the longest in the body, is superficial throughout and extends from the pelvis to the leg. It arises from the anterior superior spine of the ilium and the ridge of bone below it to the extent of about an inch (2.5 centimeters). It passes obliquely over the front to the inner side of the thigh and descends upon the roof of Hunter's canal in the groove between the vastus internus on the outer side and the adductor longus and magnus muscles on the inner side. It then crosses the adductor magnus and terminates in a flat tendon which passes behind the internal condyle of the femur, over the internal lateral ligament of the knee-joint, and expands into a broad aponeurosis which covers the tendons of the gracilis and semitendinosus and is inserted into the upper anterior part of the shaft of the tibia and the deep fascia of the leg. This tendon by some anatomists is described as one of the inner hamstring tendons. From the upper margin of the tendinous expansion an offset is derived which blends with the tendon of the quadriceps extensor covering the knee. A bursa is interposed between the tendinous expansion and the tendons of the gracilis and semitendinosus, and a larger one between the tendon and the internal lateral ligament of the knee-joint. Either of these bursæ may become enlarged, particularly the former in women who ride on horseback. The sartorius in its course crosses the rectus femoris, iliacus, psoas, pectineus, vastus internus, adductor longus, and adductor magnus muscles, the anterior crural nerve, the sheath of the femoral vessels, the long saphenous nerve, the internal condyle of the femur, the internal lateral ligament of the knee-joint, and the tendons of the gracilis and semitendinosus muscle. It is frequently pierced at its upper part by a division of the middle cutaneous nerve, and near the knee is crossed by the anterior branch of the internal cutaneous nerve and the long saphenous vein, the deep fascia intervening between the muscle and the vein.

The sartorius is the guide to the superficial femoral artery in its ligation both at the apex of Scarpa's triangle and in Hunter's canal, at both of which points the muscle is displaced outward.

In Barker's operation the hip-joint is excised through an incision carried along the outer border of the sartorius below its origin, striking off the interval between it and the tensor fasciæ femoris.

The sartorius has been ruptured, yet from its length and peculiar action this

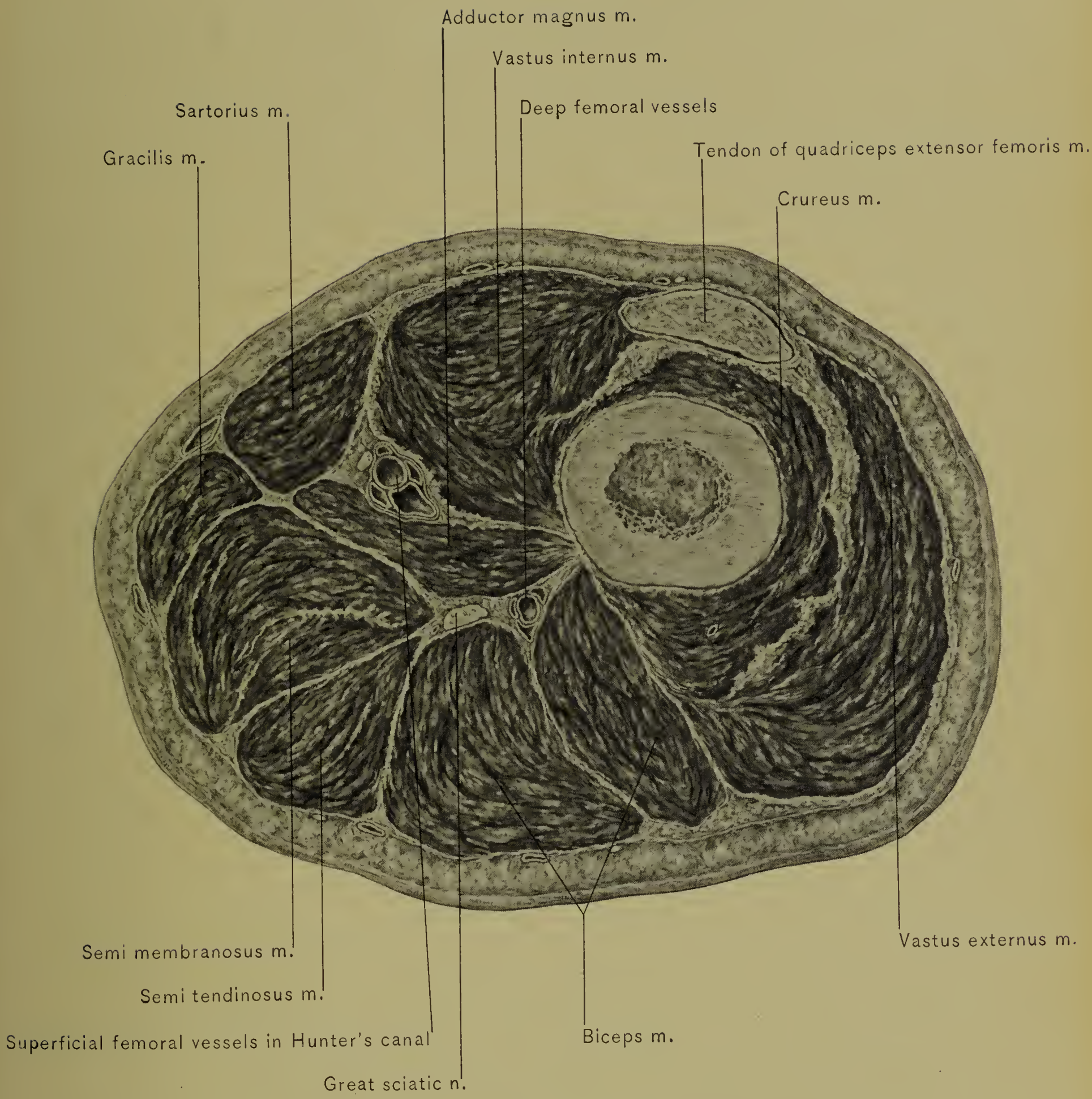
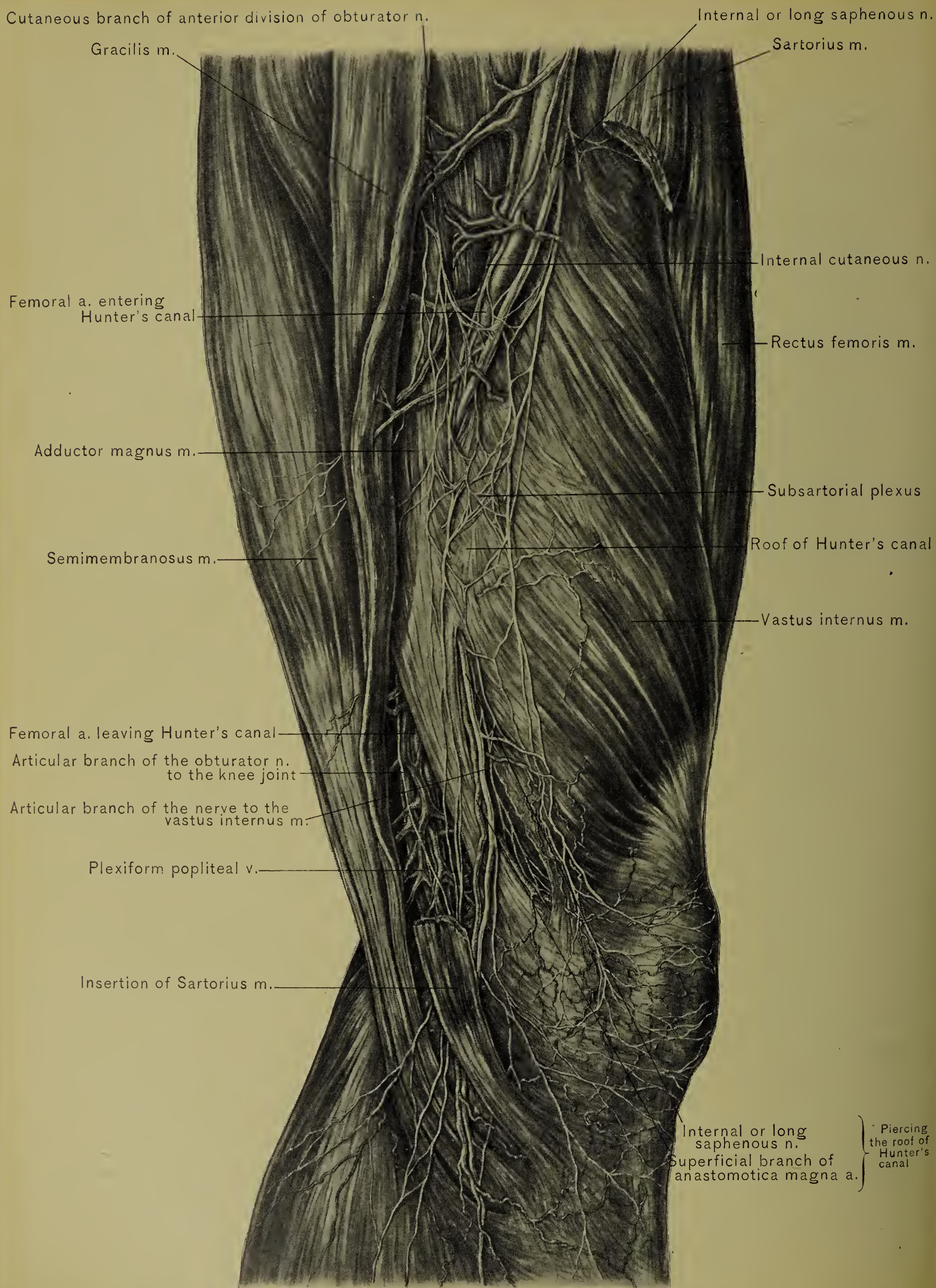


DIAGRAM OF HUNTER'S CANAL.



HUNTER'S CANAL AND CONTAINED STRUCTURES.

would not be expected. Treves refers to a case of rupture of its tendinous expansion with dislocation backward of the muscle. The tendons of the sartorius and gracilis are the landmarks in finding the long saphenous nerve at the inner side of the knee, where the nerve, in company with the superficial branch of the anastomotica artery, pierces the deep fascia between these tendons.

NERVE SUPPLY.—The sartorius receives its nerve supply from the middle cutaneous branch of the anterior crural nerve.

ACTION.—The sartorius flexes the leg upon the thigh and the thigh upon the abdomen. It rotates the thigh outward and abducts it; when the knee is flexed, it rotates the leg inward. If the legs be fixed, the two muscles acting would flex the pelvis upon the thighs. When standing upon one leg, it assists in rotating the body, carrying its side of the pelvis forward. Its chief action, however, is to steady the pelvis upon the thigh (Holden).

Hunter's Canal.—By displacing the sartorius outward, a dense aponeurotic lamina four or five inches (10 to 12.5 centimeters) in length, extending from the apex of Scarpa's triangle above, to the opening in the adductor magnus below, will be seen upon the inner aspect of the middle third of the thigh. This lamina is the roof of Hunter's canal which stretches from the vastus internus on the outer side, to the adductor longus and magnus on the inner side. It is pierced by the long saphenous nerve and the superficial branch of the anastomotica magna artery.

DISSECTION.—Divide the roof of Hunter's canal without injuring the long saphenous nerve and the anastomotica magna artery.

Hunter's canal is a trough-shaped space about four inches (10.0 centimeters) in length in the middle third of the thigh, extending from the apex of Scarpa's triangle to the opening in the adductor magnus. It is bounded externally by the vastus internus, antero-internally by the roof, and posteriorly by the adductor longus and magnus. It contains the superficial femoral artery and vein, the long saphenous nerve, and the anastomotica magna artery.

The **Femoral Arteries** are the common, the superficial, and the deep femoral (profunda femoris).

The **common femoral** is the continuation of the external iliac artery, and begins at the lower border of Poupart's ligament, midway between the anterior superior spinous process of the ilium and the symphysis pubis. It passes downward in Scarpa's triangle for about two inches (5.0 centimeters) and divides into the superficial and the deep femoral. The point of division in about three-fourths of the cases is between one and two inches (2.5 and 5.0 centimeters) below Poupart's ligament.

The **superficial femoral artery** consists of two portions, that which occupies Scarpa's triangle, the superficial portion, and that situated in Hunter's canal, the

deep portion. The superficial femoral being the continuation of the common femoral, a line drawn from a point midway between the anterior superior spinous process of the ilium and the symphysis pubis to the adductor tubercle, or the most prominent part of the internal condyle, the limb being in the position of slight outward rotation and abduction, would represent the course of both vessels.

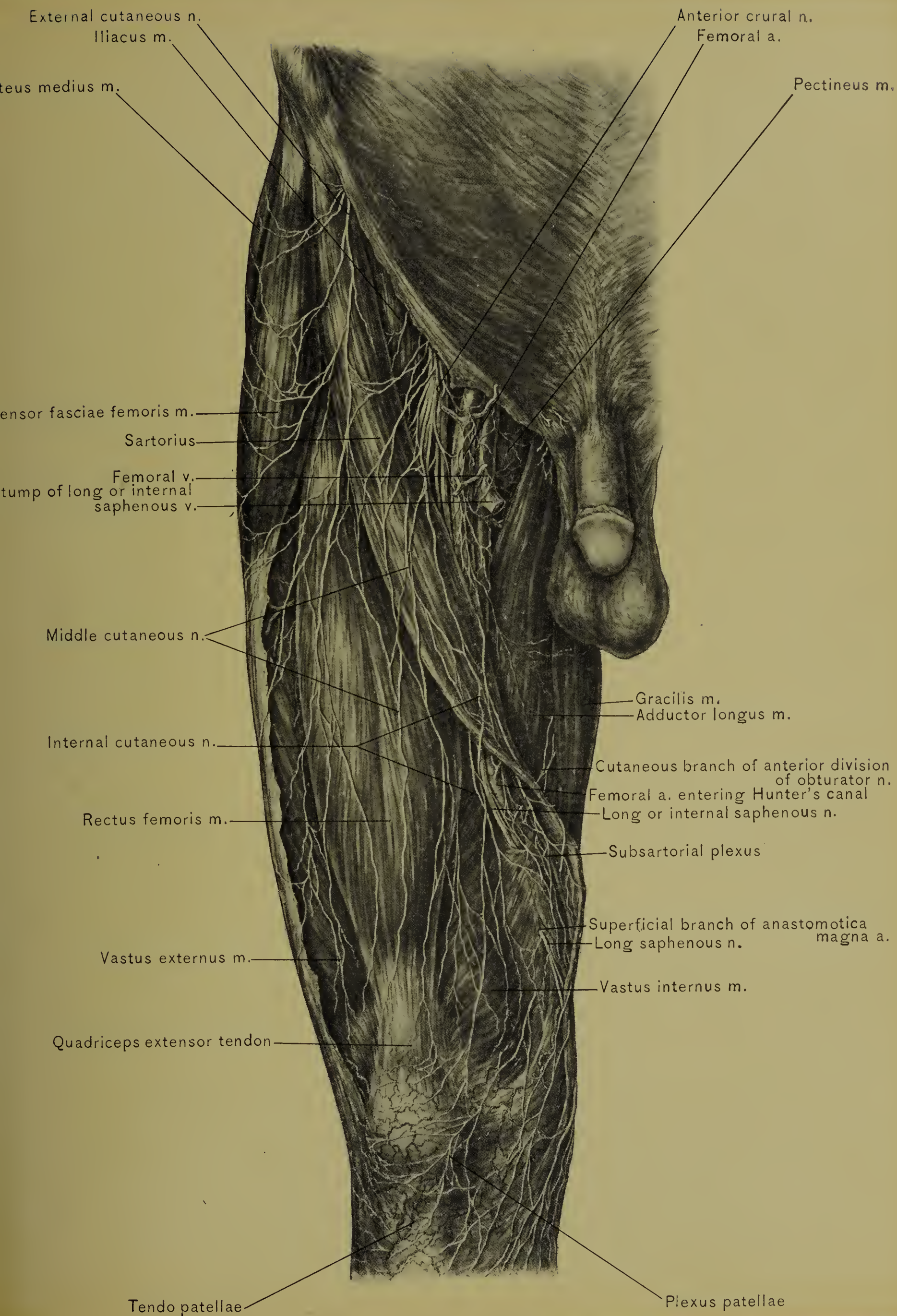
RELATIONS OF THE COMMON FEMORAL ARTERY.—In front of it are the crural branch of the genito-crural nerve, the anterior portion of the sheath of the femoral vessels, the iliac portion of the fascia lata, the superficial epigastric artery and vein, and the superficial circumflex iliac vein. Behind it are the posterior portion of the sheath of the vessels, the pubic portion of the fascia lata, the nerve to the pectineus, the psoas and pectineus muscles, and the capsular ligament of the hip-joint. On the inner side are the common femoral vein and the septum between the artery and vein. On the outer side are the anterior crural nerve and its branches at their origin.

Although the artery lies over the inner part of the head of the femur, it is not easily compressed here, as the vessel is likely to slip from under the finger on account of the mobility of the head of the bone. Because of the relation of the vessel to the head of the femur, the latter can be located by the pulsations of the vessel. To locate the head of the femur is important in the diagnosis of fracture of the neck of the bone and in determining whether or not union has taken place.

RELATIONS OF THE SUPERFICIAL PORTION OF THE SUPERFICIAL FEMORAL ARTERY.—In front of it are the posterior branch of the internal cutaneous nerve, the sartorius muscle, and the fascia lata. Behind it are the profunda vessels, the pectineus muscle, and the fascia lata. Behind and to the inner side, at the apex of Scarpa's triangle, is the superficial portion of the superficial femoral vein. On the outer side are the long saphenous nerve and the nerves to the vastus internus and the vastus externus. The distance of the artery from the surface increases as it descends. The proximity of the artery to the surface in the superficial portion of its course renders its pulsations visible if the limb be extended, and readily accessible both for pressure and ligation. The superficial femoral artery gives off branches to the sartorius and vastus internus muscles in Scarpa's triangle.

DISSECTION.—To expose the deep portion of the superficial femoral artery, the roof of Hunter's canal is to be laid open.

RELATIONS OF THE DEEP PORTION OF THE SUPERFICIAL FEMORAL ARTERY.—In front is the long saphenous nerve, the roof of the canal, the vastus internus, and the sartorius. Behind it are the adductor longus and magnus, and at the upper part of the canal the deep portion of the superficial femoral vein; while below, the vein lies to the outer side. On the outer side are the vastus internus, the long



MUSCLES, VESSELS, AND NERVES OF FRONT OF THIGH.

saphenous nerve in the upper part of the canal, and the deep portion of the superficial femoral vein in the lower part of the canal. On the inner side are the adductor longus and magnus, the junction of the roof of the canal with these muscles, and the long saphenous nerve in the lower part of the canal.

The **branches of the common femoral** are the superficial epigastric, superficial external pudic, superficial circumflex iliac, deep external pudic, and profunda femoris arteries. The three superficial vessels have already been described with the superficial fascia.

The **deep external pudic artery** passes inward over the pectineus beneath the pubic or pectineal portion of the fascia lata, which it pierces at the ramus of the pubes. It supplies the pectineus, the scrotum in the male, and the labium in the female. It anastomoses with the superficial perineal artery.

The **superficial femoral artery** is the continuation of the common femoral.

The *branches of the superficial portion* of the superficial femoral artery are the muscular and the saphenous. The muscular branches supply the sartorius, rectus femoris, and vastus internus muscles.

The *branches of the deep portion* of the superficial femoral artery are the anastomotica magna artery and muscular branches.

The **anastomotica magna artery** arises from the deep portion of the superficial femoral just before it leaves Hunter's canal. It divides into a superficial and a deep branch. The *superficial branch* pierces the roof of Hunter's canal, accompanies the long saphenous nerve beneath the sartorius and between the tendons of the sartorius and gracilis, pierces the deep fascia, and supplies the integument of the upper and inner part of the leg. It anastomoses with the inferior internal articular artery and the recurrent branch of the anterior tibial artery. The *deep branch* enters the vastus internus, through the substance of which it passes, in front of the tendon of the adductor magnus muscle, to the knee, where it anastomoses with the superior and inferior internal articular arteries and the recurrent branch of the anterior tibial. A branch of considerable size passes outward above the patella, and, with the superior external articular artery, forms the anastomotic arch, from which branches are given off to supply the knee-joint. The anastomotica magna artery gives off *muscular branches* to supply the adjacent muscles.

Anomalies of the femoral artery.—There are recorded a few cases of double superficial femoral; also cases where the common femoral as the continuation of the sciatic or internal iliac artery passed out of the pelvis through the great sacro-sciatic notch and accompanied the great sciatic nerve to the popliteal space, where it continued as the popliteal. In such cases the external iliac artery ends in the profunda femoris artery or some other of the usual branches of the common

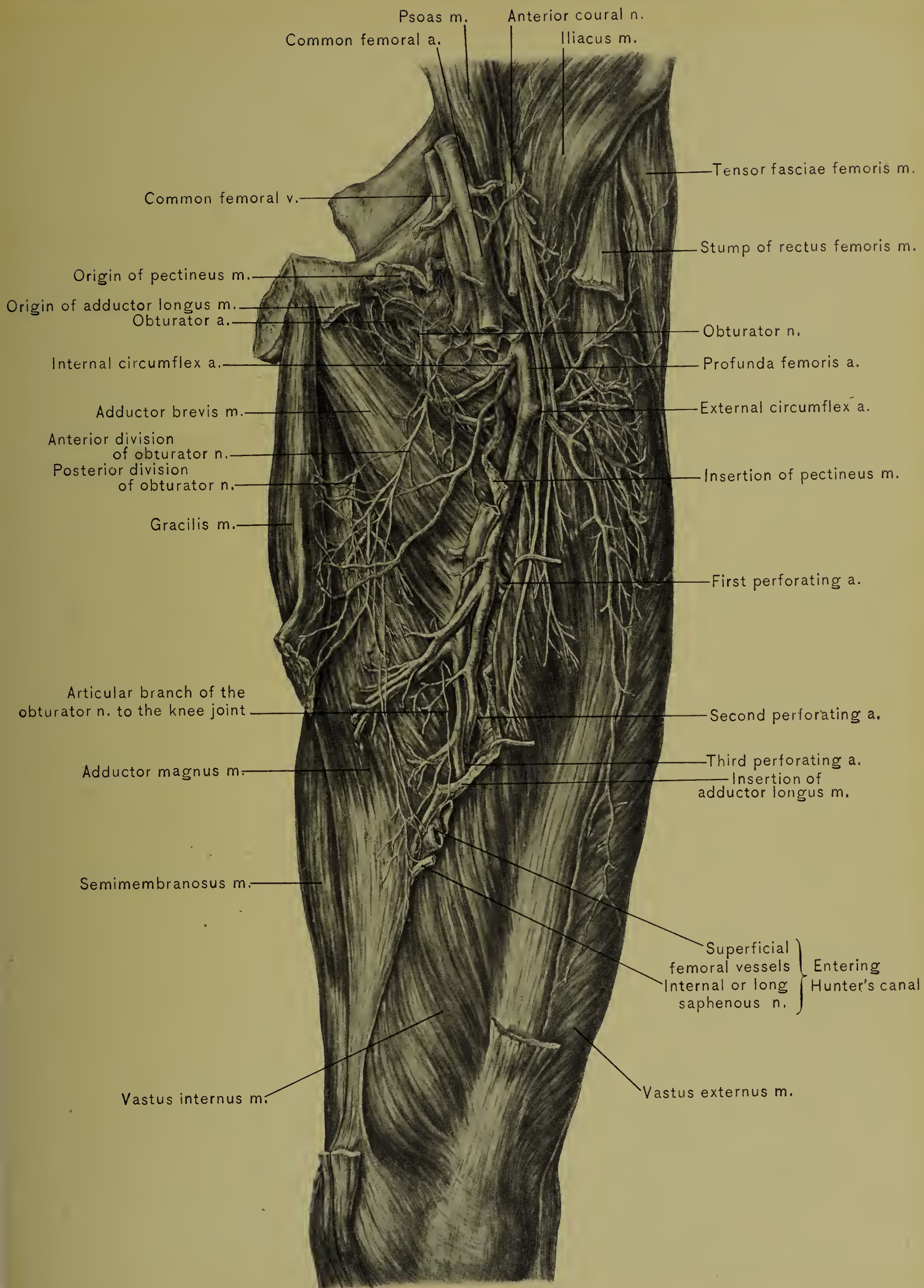
femoral artery. There may occasionally be present an artery connecting the external iliac with the femoral artery, running by the inner side of those vessels.

The **deep femoral artery** (*profunda femoris*), the main nutrient vessel of the thigh, comes off from the outer and back part of the common femoral one or two inches (2.5 to 5.0 centimeters) below Poupart's ligament. It has been seen to arise less than one inch (2.5 centimeters) below the ligament, even opposite to the ligament; in one case, above the ligament, from the external iliac. It occasionally arises more than two inches (5.0 centimeters) below the ligament; in one case it arose at as great a distance as four inches (10.0 centimeters) below the ligament (Gray). In the cases in which the common femoral artery arises from the sciatic or internal iliac artery, the deep femoral artery is usually the direct continuation of the external. In the first two inches (5.0 centimeters) of its course it lies to the outer side of the superficial femoral artery. It then passes downward and inward behind the deep femoral vein, the adductor longus muscle, and the superficial femoral artery and vein, to reach the inner side of the femur. It terminates at the lower third of the thigh in a small branch, the fourth perforating, which pierces the adductor magnus. It supplies the adductor and flexor muscles.

RELATIONS OF THE DEEP FEMORAL ARTERY.—It lies upon the iliacus, pectineus, adductor brevis, and adductor magnus muscles. It is separated from the superficial femoral artery above by the superficial and deep femoral veins, and below by the tendon of the adductor longus. On the outer side of the artery are the vastus internus and the angle of junction of the adductor longus with the adductor brevis and magnus. On the inner side are the pectineus, the adductor brevis, and the magnus. In the first part of its course, where it lies to the outer side of, but on a plane posterior to, the superficial femoral, it has been mistaken for that artery (Holden). Here it is covered by branches of the anterior crural nerve and the deep fascia.

The branches of the profunda femoris are the internal and external circumflex, and the three perforating arteries.

The **external circumflex artery** arises from the outer side of the profunda, about three-fourths of an inch (1.9 centimeters) below the origin of that vessel, passes transversely outward over the iliacus muscle between the branches of the anterior crural nerve beneath the sartorius and rectus muscles, and divides into three sets of branches—ascending, transverse, and descending. The *ascending branches* run to the outer side of the ilium beneath the sartorius, tensor fasciæ femoris, and gluteus medius muscles, and anastomose with the gluteal and deep circumflex iliac arteries. The *transverse branches* pass directly outward between the rectus and crureus and pierce the vastus externus. They reach the back of the thigh and anastomose with the internal circumflex, sciatic, and superior perforating arteries



PROFUNDA FEMORIS ARTERY AND OBTURATOR NERVE.

to form the **crucial anastomosis**. The *descending branches*, two or three in number and of considerable size, run beneath the rectus and between the crureus and vastus externus, to which they are distributed. The longest branch runs in the substance of the vastus externus, and anastomoses with the superior external articular branch of the popliteal. This branch reaches the outer side of the knee, where it is accompanied by the nerve to that muscle.

The **internal circumflex artery** arises from the inner and back part of the profunda opposite the external circumflex, and runs backward between the psoas and pectineus; next, between the obturator externus and the upper border of the adductor magnus; and then between the adductor magnus and quadratus femoris. Deep in the thigh it sends a branch upward to supply the adductors and the obturator externus. It anastomoses with the obturator artery. Another branch descends between the adductor brevis and magnus in relation with the posterior branch of the obturator nerve. The terminal portion of the vessel, which will be exposed in the dissection of the back of the thigh, will be seen emerging from between the quadratus femoris and the upper portion of the adductor magnus. It takes part in forming the so-called crucial anastomosis which has been described. The internal circumflex sometimes gives off, opposite the hip-joint, an articular branch which enters the joint beneath the transverse ligament and supplies the synovial membrane and the head of the bone.

The circumflex arteries may vary in their origin. Sometimes they arise separately from the common femoral above the profunda. The external circumflex may be double; and the internal circumflex may be a branch of the external iliac artery, or of one of its branches.

The **perforating arteries**, three in number, are so called because they perforate the tendons of the adductor brevis and magnus to reach the back of the thigh. They supply the muscles which they pierce, and the flexors, the vastus externus, the vastus internus, and the gluteus maximus.

The *first or superior perforating artery* passes backward between the pectineus and adductor brevis, and pierces the adductor magnus near the bone. It sends a branch upward beneath the gluteus maximus which anastomoses with the internal and external circumflex and the sciatic to form the crucial anastomosis, and another downward to anastomose with the middle perforating artery.

The *second or middle perforating artery*, the largest, arises between the adductor longus and adductor brevis. It pierces the adductor brevis and magnus muscles near the linea aspera and divides into an ascending and a descending branch which anastomose respectively with the superior and inferior perforating arteries. The nutrient artery of the femur is usually a branch of this artery, but occasionally arises from the third perforating artery.

The *third* or *inferior perforating artery* arises between the adductor longus and magnus near the lower border of the adductor brevis. It pierces the adductor magnus near the linea aspera and divides into an ascending and a descending branch which anastomose respectively with the second perforating artery above, and the fourth perforating and muscular branches of the popliteal artery below.

The *terminal portion of the profunda*, or *fourth perforating artery*, pierces the adductor magnus just above the exit of Hunter's canal. It anastomoses with the third perforating artery and with muscular and superior articular branches of the popliteal.

The Femoral Veins.—The common and superficial femoral veins, the accompanying vessels of the respective arteries, have the following arrangement: The common, formed by the union of the superficial and deep femoral, lies to the inner side of the common femoral artery and terminates at the lower border of Poupart's ligament in the external iliac vein. The vein, at its termination, with the inner of the two vertical septa of the femoral sheath, forms the outer boundary of the femoral (crural) ring and femoral canal. Emptying into the common femoral are the long saphenous and the deep external pudic veins. Thrombosis of the common femoral vein, most often the left, is one of the complications of typhoid fever.

The **superficial femoral vein**, like the artery, consists of a superficial and a deep portion. It is the continuation of the popliteal vein and begins at the opening in the adductor magnus, through which it passes. The deep portion of the vein lies to the outer side of the deep portion of the artery in the lower part of Hunter's canal, and is rather firmly adherent to the artery in the situation; as it ascends it gradually passes behind the artery. The superficial portion of the vein lies behind the superficial femoral artery at the apex of Scarpa's triangle, and passes to the inner side of the artery in its course upward. The vein may be double, or plexiform, in Hunter's canal.

The **deep femoral vein** accompanies the deep femoral artery, lying anterior to that vessel. Its tributaries correspond to the branches of the artery. It joins the superficial femoral vein one and one-half (3.75 centimeters) or two inches (5.0 centimeters) below Poupart's ligament to form the common femoral vein.

The anterior crural nerve.—Emerging from beneath Poupart's ligament about one-fourth of an inch (0.6 centimeter) to the outer side of the common femoral artery, in the depression between the psoas and iliacus muscles, is the anterior crural nerve, the largest branch of the lumbar plexus, covered by the iliac fascia. It arises from the second, third, and fourth lumbar nerves, and runs through the psoas muscle. In psoas abscess it is left intact, although the muscle may be entirely removed by necrosis. In the groove between the

psoas and iliacus muscles it divides into two portions—an anterior and a posterior. From the *anterior portion* of the nerve arise the muscular branches to the pectineus and sartorius—the middle cutaneous and internal cutaneous nerves.

The *nerve to the pectineus* passes inward behind the sheath of the common femoral vessels and pierces the iliac fascia to enter the muscle. The nerve to the sartorius muscle is a part of the middle cutaneous.

The *middle cutaneous* and *internal cutaneous nerves* have been described.

From the *posterior portion* of the anterior crural nerve arise the long saphenous nerve and muscular and articular branches.

The *long saphenous nerve*, the longest branch of the anterior crural, passes downward and inward, close to the outer side of the superficial femoral artery, approaching this vessel where it is crossed by the sartorius muscle. At this point the nerve enters Hunter's canal, lying at first to the outer side of the artery, next in front of the artery, and then to the inner side of the artery. With the superficial branch of the anastomotica magna artery it leaves the canal by piercing the lower portion of the roof. It descends with the superficial branch of the anastomotica magna beneath the sartorius to the inner side of the knee, where it lies between the tendons of the sartorius and gracilis, pierces the deep fascia, and leaves the artery. It then accompanies the long saphenous vein along the inner side of the leg. About the middle of the thigh it gives off a branch which communicates with the obturator and internal cutaneous nerves, to form the subsartorial plexus. The *subsartorial plexus* is found along the inner border of the sartorius just below the middle of the thigh. It supplies the adjacent skin and fascia. Beneath the sartorius the long saphenous nerve gives off a large branch (patellar branch) which pierces that muscle and the overlying deep fascia and runs downward along the inner side of the patella and over the ligamentum patellæ to supply the integument. The patellar branch gives off a twig to the patellar plexus. The long saphenous nerve must not be confounded with the nerve to the vastus internus muscle, which lies to its outer side.

The *muscular branches* supply all the muscles of the anterior part of the thigh, except the sartorius, which is supplied by the middle cutaneous, and the tensor fasciæ femoris, which is supplied by the superior gluteal. The branches to the rectus muscle enter its under surface high up. One of them sends an articular branch to the hip-joint. The branch to the vastus internus muscle lies along the outer side of the long saphenous nerve. The branch to the vastus externus is accompanied by the descending branch of the external circumflex artery. The nerve to the crureus sends a branch to the upper part of that muscle and runs downward between the crureus and vastus internus and supplies the subcrureus and the synovial membrane of the knee-joint.

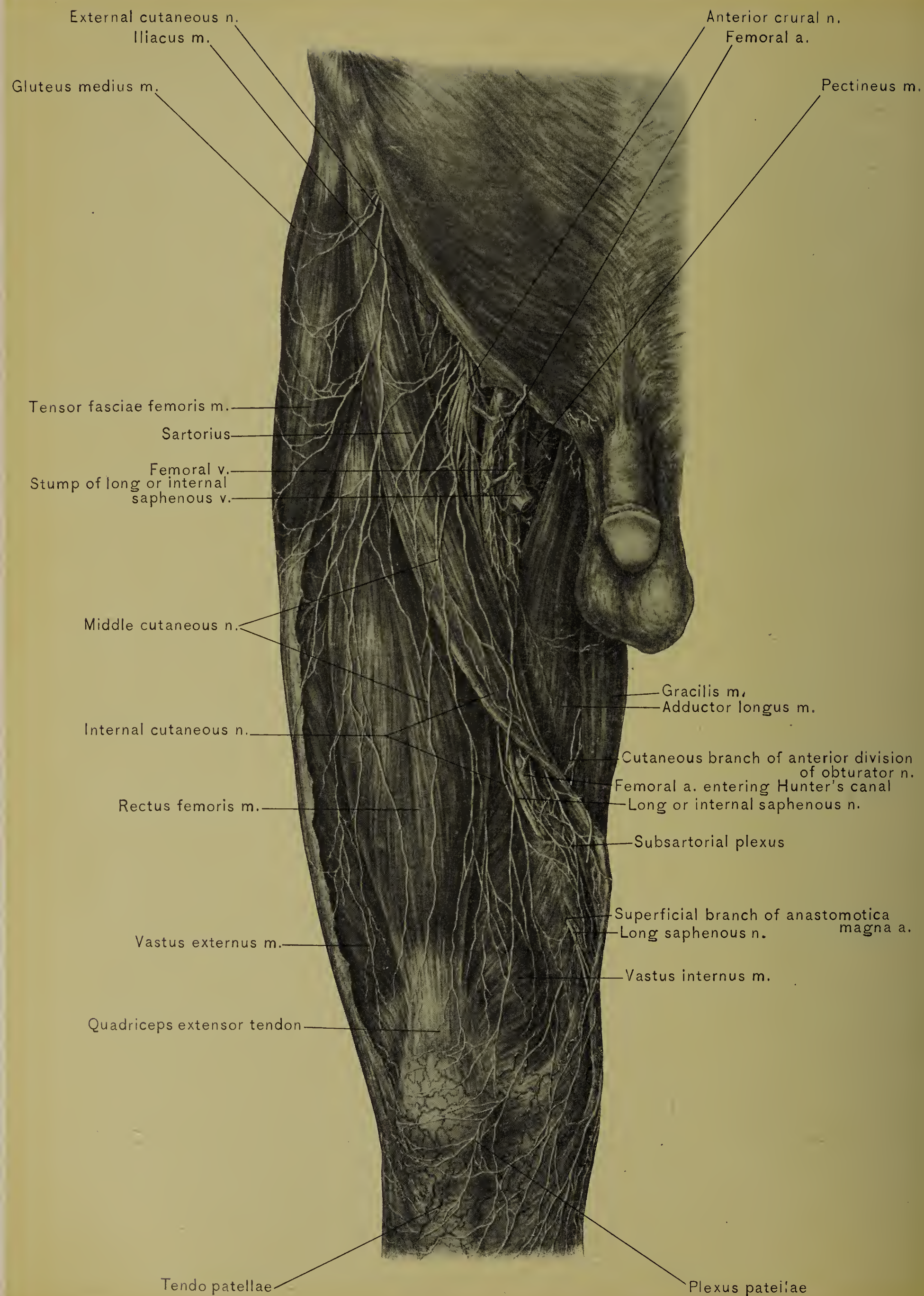
The *articular branches* supply the hip-joint and knee-joint. The articular twigs to the hip-joint come from a nerve to the rectus femoris muscle. The articular twigs to the knee-joint come from the nerves to the vastus internus and externus.

The **quadriceps extensor femoris muscle** occupies the front of the thigh and is situated between the tensor fasciæ femoris and ilio-tibial band on the outer, and the adductors on the inner side. This muscle includes the rectus femoris and triceps femoris muscles, the latter comprising the vastus externus, the crureus, and the vastus internus muscles.

The **rectus femoris muscle** occupies the middle of the front of the thigh. It arises by two heads: the anterior or short head, from the anterior inferior spine of the ilium; the posterior, long, or reflected head, from the outer surface of the ilium above the acetabulum. The long or reflected head is attached to the capsule of the hip-joint. The two heads unite and the muscle then descends as a bipenniform fleshy mass along the front of the thigh. It is inserted through the common extensor tendon into the upper border of the patella. It will therefore be seen that the rectus muscle is not attached to the femur, but passes over it from the ilium above to the patella below. Note that the upper part of the anterior and the lower part of the posterior surface of the rectus muscle are aponeurotic. In front of the rectus are part of the gluteus minimus, the tensor fasciæ femoris, the sartorius, the iliacus, and the fascia lata. It rests upon the capsule of the hip-joint, the external circumflex vessels, and the crureus and vasti muscles.

NERVE SUPPLY.—It receives its nerve supply from the posterior division of the anterior crural nerve.

The **vastus externus muscle** is the largest of the muscles forming the triceps, and produces a prominence on the outer side of the lower part of the thigh. It is covered by a dense aponeurosis and arises from the upper half of the anterior intertrochanteric line and the femur immediately below this point, from the front and outer surface of the base of the great trochanter, from the anterior margin of the gluteal ridge, from nearly the whole length of the outer lip of the linea aspera, and to a slight extent from the external intermuscular septum near the linea aspera. The fibers pass downward and forward and terminate in an aponeurosis which is inserted into the upper and outer borders of the patella, forming a part of the common extensor tendon and becoming connected with the capsule of the knee-joint. It is covered by the ilio-tibial band of fascia lata, the fascia lata, the rectus femoris, the tensor fasciæ femoris, and the gluteus maximus. A bursa is interposed between this muscle and the gluteus maximus. It rests on the femur, the crureus muscle, the descending branch of the external circumflex artery, and the muscular branch of the anterior crural nerve, which



MUSCLES, VESSELS, AND NERVES OF FRONT OF THIGH.

supplies it. This artery and nerve therefore lie between it and the crureus muscle.

NERVE SUPPLY.—Its nerve supply is derived from the anterior crural nerve.

The **vastus internus** and the **crureus muscles**, being continuous with each other, are best described as one muscle. Making an arbitrary division, that portion of the muscle lying beneath the rectus would be the crureus; and that to the inner side, the vastus internus. Immediately above the patella and beneath the tendon of the rectus there is a narrow interval which marks the line of separation between the tendon of the vastus internus and that of the crureus. These muscles arise from the rough line leading from the lesser trochanter to the linea aspera, from the entire length of the inner lip of the linea aspera, from the internal condyloid ridge above the opening in the adductor magnus, from the internal intermuscular septum, from the anterior intertrochanteric line, and the upper three-fourths of the anterior and outer surface of the femur in front of and below the attachment of the vastus externus. The fibers composing the vastus internus pass downward and forward, while those composing the crureus pass vertically downward. They are inserted by an aponeurosis into the upper and inner borders of the patella to form part of the common extensor tendon. This aponeurosis, like that of the vastus externus muscle, gives off a fibrous expansion to the capsular ligament of the knee-joint. The vastus internus forms the prominence in the lower part of the thigh above the inner side of the knee. The two muscles are covered by the sartorius, rectus femoris, and iliacus muscles, and the deep fascia, or fascia lata. They rest upon the femur, the subcrureus, and the synovial membrane of the knee-joint. The vastus internus muscle helps to form Hunter's canal, the femoral vessels and the long saphenous nerve being in relation with the muscle in this part of the thigh.

NERVE SUPPLY.—The crureus in its upper part receives numerous branches from the posterior division of the anterior crural nerve. The nerve to the vastus internus is a large branch that lies to the outer side of the femoral artery in the upper part of Hunter's canal.

The extensor tendon.—By the union of the tendons of the rectus, vastus externus, vastus internus, and crureus muscles a broad flat tendon is formed, the **common extensor tendon**, which is inserted into the upper border and sides of the patella. The common extensor tendon is prolonged beyond the patella as a thick narrow tendon about two inches (5.0 centimeters) in length, the **tendo patellæ**, or **ligamentum patellæ**, which passes in front of the knee-joint, and is inserted into the lower part of the tubercle of the tibia. Between the tendo patellæ and the overlying integument in the superficial fascia is a synovial bursa (*bursa patellæ*), enlargement of which constitutes "housemaid's knee." Between the tendo patellæ

and the upper part of the tubercle of the tibia is a second bursa, while between the femur and the portion of the common extensor tendon formed by the tendon of the crureus is a bursa of considerable size, which, in the majority of adults, communicates with the synovial sac of the knee-joint. Under such circumstances synovitis of the knee with distention of the synovial sac occasions a prominence immediately above the patella. When the synovial membrane of the knee is very greatly distended, it will extend some distance above and to the sides of the patella, forcing its way beneath the surrounding muscles which in this situation are connected to the femur by loose connective tissue. The common extensor tendon, the expansions of the vasti muscles, the patella, the tendo patellæ, and the ilio-tibial band afford ample protection to the front and sides of the knee-joint, which are most exposed to injury.

The **subcrureus muscle**, some of the lower fibers of the crureus, arises from the anterior surface of the lower part of the femur and is inserted into the synovial membrane of the knee-joint. When the muscle acts, it draws the upper portion of the synovial membrane upward, preventing its being pinched in full extension of the joint.

NERVE SUPPLY.—It derives its nerve supply from the branch to the vastus internus muscle.

ACTION.—The action of the quadriceps extensor muscle, as its name indicates, is to extend the leg upon the thigh. The rectus muscle, in addition to being an extensor of the leg, is a flexor of the thigh upon the pelvis. When acting from its point of insertion, the rectus muscle flexes the pelvis on the thigh. The quadriceps extensor muscle is one of the most powerful muscles of the body, which is often demonstrated by its breaking the patella transversely in the attempt to recover the erect position when falling. In this fracture the fibrous covering of the patella is also torn through. The resulting union, if the fragments be not brought into direct apposition by the removal of any dangling fragments of the torn capsule, is fibrous. When fracture of the patella is the result of direct violence, the fibrous covering remains intact. In violent contraction of the rectus, instead of fracture of the patella resulting, a few of its fibers may be ruptured, producing a severe sprain, or it may be torn from the patella, or the ligamentum patellæ may be ruptured.

The **tensor fasciæ femoris** is situated at the upper third and on the outer aspect of the thigh, between the gluteus medius and the sartorius. It arises from the anterior part of the external lip of the crest of the ilium, from the surface of the bone below the anterior superior spine, and from the fascia lata. It passes downward and slightly backward and is inserted into that portion of the fascia lata called the ilio-tibial band, at the junction of the upper with the middle third of the

thigh. It is an internal rotator of the thigh, acting in conjunction with the anterior fibers of the gluteus medius. It also assists in fixing the pelvis upon the thigh.

NERVE SUPPLY.—It receives its nerve supply from a branch of the superior gluteal nerve.

ACTION.—It is a tensor of the fascia lata; by continuing its action it also abducts the thigh and rotates it inward. When the body is erect, it steadies the pelvis upon the femur, and by the ilio-tibial band it steadies the condyles of the femur on the tibia, by acting from below. It also assists the gluteus maximus muscle to support the knee in extension.

The ilio-psoas tendon.—The terminal portions of the iliacus and psoas magnus muscles, seen to the outer side of the femoral vessels at the upper part of the thigh, form the ilio-psoas tendon, which winds downward and backward over the capsular ligament of the hip-joint to be inserted into the lesser trochanter of the femur. Between the tendon and capsule is placed a bursa which often communicates with the joint. When the bursa is the seat of chronic inflammation, it may form a tumor on the front of the thigh the size of a fetal head (Nancrede). Owing to the close proximity of the bursa to the bony pelvis, suppuration of it may lead to necrosis of the pelvis (Nancrede). When the bursa is inflamed, the thigh is flexed on the pelvis to relieve tension. This position of the limb, together with tenderness, pain, and swelling to the extent of obliterating the normal crease of the groin, may lead the inexperienced to conclude that the case is one of hip-joint disease.

Psoas abscess.—To the outer side of the femoral vessels, at the upper part of the thigh, a psoas abscess most commonly points, finding its way here beneath the ilio-psoas fascia.

NERVE SUPPLY.—The psoas and iliacus muscles receive their nerve supply from the anterior crural.

ACTION OF THE ILIO-PSOAS.—The iliacus and psoas magnus muscles act as flexors, adductors, and internal rotators of the thigh. They have been described with the abdomen and pelvis.

The **Adductor Muscles**, which include the pectineus, gracilis, adductor longus, adductor brevis, and adductor magnus muscles, should next be studied. The obturator externus muscle also acts as an adductor, but it is chiefly an external rotator.

The **gracilis**, a long, flat muscle, and the most internal of the adductor group, arises by a broad thin tendon two or three inches (5.0 to 7.5 centimeters) wide from the inner margin of the body and ramus of the pubes. It is superficial throughout, and terminates in a round tendon which passes behind the internal condyle of the femur, over the internal lateral ligament of the knee-joint, and between the tendons of the semitendinosus and sartorius muscles to be inserted

into the upper part of the inner side of the shaft of the tibia below the inner tuberosity. The tendon as it passes over the internal lateral ligament has beneath it a bursa which is common to it and the tendon of the semitendinosus. It is one of the inner hamstring tendons. Between the tendons of the gracilis and the sartorius passes the long saphenous nerve.

NERVE SUPPLY.—The nerve supply is derived from the anterior branch of the obturator nerve.

ACTION.—The action of the gracilis is to adduct the thigh and flex the knee. If the knee be flexed, the gracilis would assist in the inward rotation of the leg.

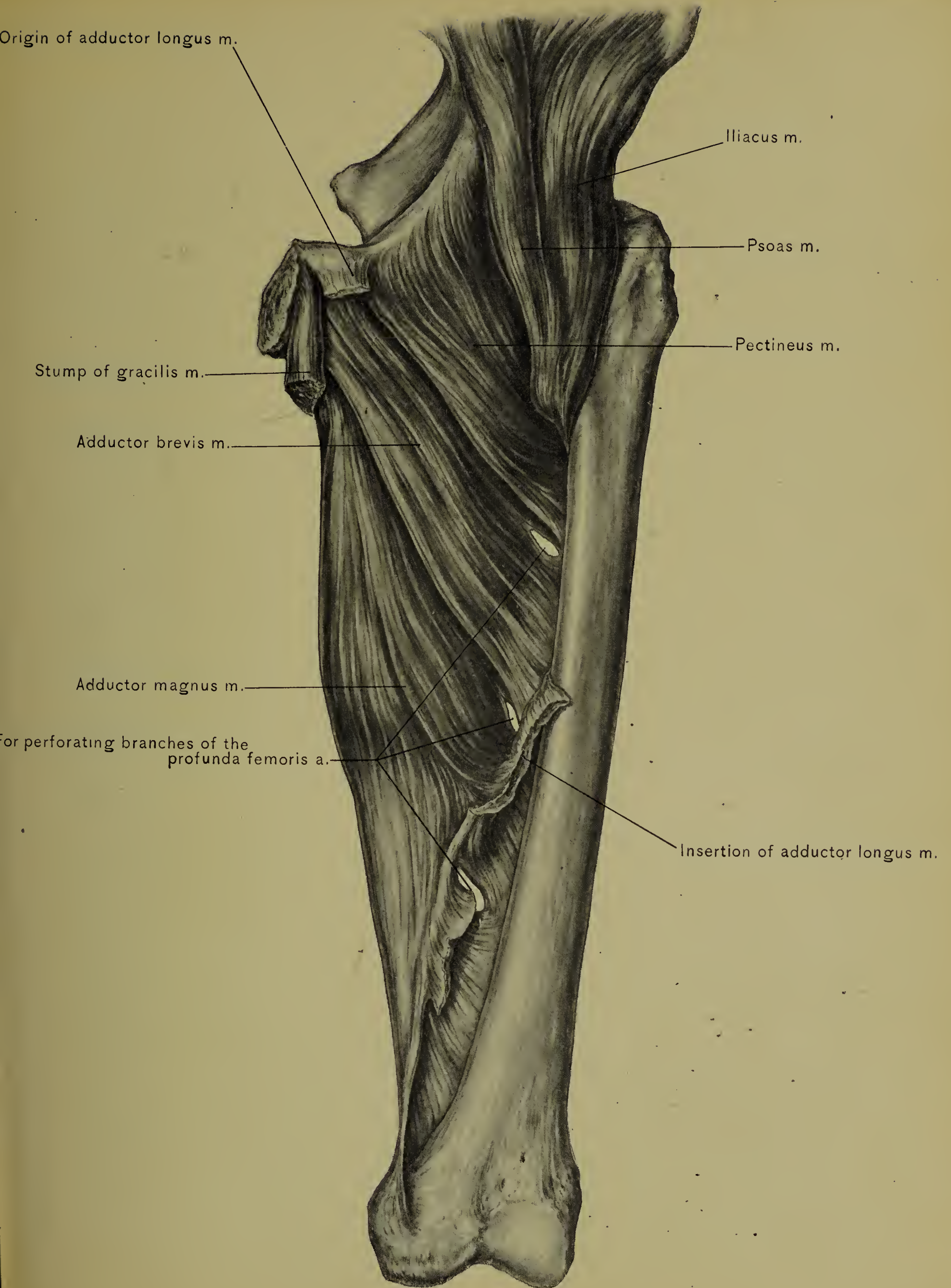
The **adductor longus muscle**, more superficial than the adductor brevis and magnus, lies between the gracilis and pectineus at its point of origin and arises by a short round tendon from the front of the body of the pubes below the crest and in the angle between the crest and symphysis. It becomes broader as it passes downward, outward, and backward, and is inserted by a broad aponeurosis into the middle third of the inner lip of the linea aspera between the vastus internus and adductor magnus, and into the adjacent internal intermuscular septum. Behind it lie the adductor brevis, the adductor magnus, the deep femoral vessels, and the anterior branch of the obturator vessels and nerve. On its outer side is the pectineus, and on its inner, the gracilis. The adductor longus and sartorius form two sides of Scarpa's triangle, already described.

NERVE SUPPLY.—The nerve supply is derived from the anterior branch of the obturator nerve.

ACTION.—The adductor longus aids in adducting and flexing the thigh; it also acts as an external rotator.

The Adductor Longus Muscle as a Landmark in Hernia.—The adductor longus muscle being superficial and arising from the front of the body of the pubes below the crest, it follows that the tendon of origin of the muscle can be distinctly felt subcutaneously when the thigh is strongly abducted. This is of use in locating the spine of the pubes which serves to differentiate between an inguinal and a femoral hernia.

The **pectineus muscle** lies on the same horizontal plane as the adductor longus muscle, but external to it. It is separated from the adductor longus muscle by a slight interval through which can be seen the adductor brevis and the anterior branch of the obturator nerve. It arises from the ilio-pectineal line between the spine of the pubes and the ilio-pectineal eminence, from the surface of the bone in front of it, and from the prolongation of Gimbernat's ligament, which is continuous with the fascia covering the muscle. It passes downward, outward, and backward, and is inserted into the femur behind the lesser trochanter and the rough line leading from the trochanter to the linea



aspera. In front of it are the common, superficial, and deep femoral vessels and the ilio-psoas tendon. Behind, it rests upon the capsular ligament of the hip-joint, the adductor brevis and obturator externus muscles, and the obturator vessels and nerve. On its outer side is the psoas magnus, but separated from it by an interval through which passes the internal circumflex branch of the deep femoral artery; on its inner side is the adductor longus.

NERVE SUPPLY.—The nerve supply is derived from the anterior crural and obturator nerves. If an accessory obturator nerve be present, it also sends a branch to the pectineus muscle.

ACTION.—The pectineus muscle acts as a flexor and adductor of the thigh and slightly as an external rotator.

DISSECTION.—The adductor longus and pectineus should be cut across near their origin and reflected. This dissection will expose the anterior surface of the capsular ligament of the hip-joint, the adductor brevis, obturator externus, and adductor magnus muscles, the terminal portion of the deep femoral vessels, and the anterior branch of the obturator nerve.

The accessory obturator nerve.—In cutting through the pectineus muscle, the accessory obturator nerve, if present, will be seen passing beneath the outer border of the muscle. It is a branch of the lumbar plexus, arising either from the obturator nerve or by filaments from the third and fourth lumbar nerves. It passes over the horizontal ramus of the pubis beneath the pectineus muscle, where it divides into the following branches: an articular branch to the hip-joint; a muscular branch to the pectineus; and a communicating branch to the anterior branch of the obturator.

The **obturator artery** enters the thigh through the upper part of the obturator foramen beneath the obturator nerve, and divides into two branches, an internal and an external, which encircle the margin of the foramen beneath the obturator externus muscle. It supplies the pectineus, gracilis, and adductor muscles and anastomoses with the internal circumflex and sciatic arteries. The external branch sends a twig through the cotyloid notch which is distributed to the ligamentum teres and head of the femur.

The **obturator nerve**, a branch of the lumbar plexus, arises from the second, third, and fourth lumbar nerves. It leaves the pelvis through the upper part of the obturator or thyroid foramen in company with the obturator vessels, but lying above them. It then divides into an anterior and a posterior branch. The anterior branch descends in front of the obturator externus and adductor brevis muscles, and beneath the pectineus and adductor longus muscles. It emerges from between the adductor longus and brevis muscles and communicates with the internal cutaneous and long saphenous nerves to form the subsartorial plexus.

From the anterior branch the following branches are derived: an articular, to the hip-joint; muscular, to the gracilis, adductor longus, pectineus, and sometimes to the adductor brevis muscles. The posterior branch pierces the obturator externus muscle and descends between the adductor brevis and magnus. From the posterior branch the following branches are derived: an articular, to the hip-joint which enters the joint through the cotyloid notch; muscular, to the obturator externus, adductor brevis and magnus muscles; and an articular to the knee-joint. The articular branch to the knee-joint pierces the adductor magnus muscle and descends on the popliteal artery and pierces the posterior ligament of the joint. Through the medium of the obturator nerve, pain in hip-joint disease is at times referred to the knee.

The **adductor brevis muscle** arises from the anterior surface of the body of the pubis below the spine and the adductor longus, and from about one inch (2.5 centimeters) of the outer surface of the descending ramus of the pubis between the gracilis and obturator externus. It broadens as it passes downward, outward, and backward to be inserted into the rough line leading from the lesser trochanter to the linea aspera and into the upper part of the linea aspera immediately behind the pectineus and the upper part of the adductor longus. In front of it are the pectineus and adductor longus muscles, the deep femoral vessels, and the anterior branch of the obturator nerve. Behind, it lies on the obturator externus and the adductor magnus muscles, the posterior branches of the obturator vessels, the posterior division of the obturator nerve, and a branch of the internal circumflex artery. On its outer side are the obturator externus muscle, the internal circumflex artery, and the ilio-psoas tendon. On its inner side are the gracilis and adductor magnus muscles. The adductor brevis muscle lies between the anterior and posterior branches of the obturator nerve.

NERVE SUPPLY.—The nerve supply is furnished by filaments from the anterior branch of the obturator nerve. At times the posterior branch instead of the anterior supplies it.

ACTION.—The adductor brevis acts as an adductor and an outward rotator of the thigh.

DISSECTION.—The adductor brevis is to be cut across near its origin and reflected, when the posterior branch of the obturator nerve and the adductor magnus muscle throughout its entire extent will be exposed.

The **adductor magnus muscle**, the largest of the adductors, has an extensive origin, from the outer surface of the descending ramus of the pubes, ascending ramus of the ischium, and tuberosity of the ischium. The fibers arising from the descending ramus of the pubes take a horizontal course and are inserted into the lower part of the linea quadrati and into the inner part of the rough line leading

from the great trochanter to the linea aspera, internal to the gluteus maximus; those from the ascending ramus of the ischium take an oblique course downward and outward and are inserted into the whole length of the linea aspera and the upper part of the internal condyloid ridge of the femur, and into the lower portion of the internal intermuscular septum; those arising from the tuberosity of the ischium form the thickest portion of the muscle, and descend almost vertically to terminate in a round tendon which is crossed by the sartorius muscle at the lower third of the thigh, and is inserted into the adductor tubercle, at the base of the inner condyle of the femur. The adductor tubercle marks the level of the top of the lower epiphysis of the femur and also of the highest part of the trochlear surface (Holden). The tubercle is the landmark in locating the part of the femur divided in the operation of osteotomy for knock-knee, the bone being cut through three-fourths of an inch (1.9 centimeters) above this point. At the junction of the middle with the lower third of the thigh behind the internal condyloid ridge the fibers of the portion of the muscle arising from the ascending ramus of the ischium are inserted into a tendinous arch bridging over an opening which gives passage to the superficial femoral vessels. This opening is the termination of Hunter's canal. It is bounded antero-externally by the femur and postero-internally by the tendinous arch. Near its insertion into the linea aspera the muscle is pierced by the four perforating arteries and the articular branch of the obturator nerve which supplies the knee-joint. The portion of the muscle inserted into the entire length of the linea aspera and the internal condyloid ridge forms a partition which separates the other muscles on the anterior and inner aspect of the thigh from the muscles on the posterior aspect. This partition will be seen to the best advantage after dissecting the back of the thigh. In front of the adductor magnus are the pectineus, the adductor brevis and longus, and the vastus internus muscles, the obturator nerve and artery, and the superficial and deep femoral vessels; above it are the internal circumflex artery and the obturator externus and quadratus femoris muscles; behind it are the biceps, the semitendinosus and semimembranosus muscles, the great sciatic nerve, and the gluteus maximus muscle; and to the inner side are the gracilis and part of the sartorius muscles.

NERVE SUPPLY.—The nerve supply is derived from the posterior branch of the obturator nerve which passes to the anterior surface of the muscle, and from branches of the great sciatic nerve which enter the posterior surface of the muscle.

ACTION.—The adductor magnus is the strongest of the adductors. The portion of the muscle arising from the tuberosity of the ischium rotates the thigh inward as well, while the remainder of the muscle rotates the thigh outward.

The action of the pectineus, gracilis, and adductors muscles is to adduct the thigh and rotate it outward. Taking their fixed point from below, they serve both to maintain the body in the erect posture and to flex the pelvis upon the femur. The pectineus and the adductor brevis and longus muscles are partial flexors of the thigh, acting in conjunction with the psoas and iliacus. The adductor group of muscles is supplied by the obturator nerve. The pectineus muscle receives additional filaments from the accessory obturator and anterior crural nerves, and the adductor magnus muscle from the great sciatic nerve.

Injuries of the adductors.—The adductor muscles, especially the adductor longus, are frequently sprained, or even partially ruptured when riding horseback, producing “rider’s sprain,” the grip on the saddle being for the most part maintained by the adductor muscles. When the fibers of the adductor longus are ruptured, hemorrhage occurs, and the blood, if not rapidly absorbed, forms a clot; the clot, undergoing organization, forms a hard mass which has been mistaken for a detached piece of the pubes (Henry Morris). When the tendon of the adductor longus is partially ossified, it constitutes “rider’s bone.”

Contraction of the adductors.—The tendon of the adductor longus may be very prominent, as a result of hip disease or of disease of the spinal cord (spastic paraplegia). When this contraction is due to disease of the spinal cord, division of the muscle rarely accomplishes good.

The **obturator externus muscle**, only the origin of which is seen in this dissection, arises from the outer surface of the body and descending ramus of the pubis, the ascending ramus of the ischium, the inner half of the outer surface of the obturator membrane, and the tendinous arch over the obturator vessels. The muscle will be more fully described under the description of the gluteal region.

Obturator hernia.—In this connection attention is directed to the anatomy of obturator hernia, which takes place through the obturator foramen between the horizontal ramus of the pubis and the upper portion of the obturator externus muscle. The hernial protrusion lies to the outer side of the adductor longus muscle and beneath the pectineus muscle, to the inner side of the capsule of the hip-joint, and to the inner side of and behind the femoral vessels. Pressure of the hernia upon the obturator nerve gives rise to pain referred to the area of distribution of that nerve. Movement of the hip also excites pain. The position which the obturator vessels hold to the hernia varies; they are sometimes in front of, and at other times on the right or left side of, the hernia. The incision to expose the hernia should be carried over the most prominent part of the tumor, dividing skin, superficial and deep fascia, care being taken to avoid wounding the long saphenous and common femoral veins. The pectineus muscle will then be exposed, at the

inner border of which, and in the interval between it and the adductor longus, the sac will be reached. It may be necessary to displace the adductor brevis downward and inward to facilitate exposure of the sac. Treves mentions a case reported by Professor Wood, in which a hernia of the adductor longus muscle through a rent in its aponeurosis was mistaken for an obturator hernia.

THE FRONT OF THE LEG AND THE DORSUM OF THE FOOT.

DISSECTION.—Before removing the skin from the anterior surface of the leg and the dorsum of the foot, the foot should be extended and held in place by hooks. Continue the incision made on the inner side of the thigh down the inner side of the leg, over the internal malleolus, along the inner border of the foot to the base of the great toe. From this incision carry a transverse incision over the ankle and another across the dorsum of the foot at the base of the toes. Reflect the skin of the front of the leg and dorsum of the foot outward to expose the superficial fascia. The superficial fascia of the leg and foot is continuous with that of the thigh, and in it run the superficial vessels and nerves. These vessels and nerves are the venous arch on the dorsum of the foot and the internal and external saphenous veins; the internal saphenous, external saphenous, and musculo-cutaneous nerves, a small branch from the external popliteal nerve and the internal terminal branch of the anterior tibial nerve. On the inner side of the foot and leg will be found the internal or long saphenous vein, and on the outer side of the foot the external saphenous vein. These veins should be traced through the fascia before it is removed, when they will be seen to originate in a venous arch on the dorsum of the foot. The venous arch, with its convexity downward, extends across the instep. It receives the veins from the toes. The internal saphenous vein begins at the inner end of the arch, passes upward in front of the internal malleolus, thence along the inner side of the leg, a short distance behind the inner border of the tibia and behind the internal condyle, to become an occupant of the thigh. The external saphenous vein arises from the outer side of the arch, passes upward behind the external malleolus, to the outer side of the tendo Achillis, along the back of the calf of the leg and between the heads of the gastrocnemius to pierce the deep fascia at the lower end of the popliteal space. It empties into the popliteal vein. These veins are accompanied throughout their course below the knee by the nerves of the same name. The superficial lymphatics of the leg, beginning in a plexus on the dorsum of the foot, gradually unite into larger trunks which accompany the long saphenous vein. The short saphenous vein is also accompanied by

lymphatics which come from the outer border of the foot and posterior aspect of the leg, and enter the popliteal glands.

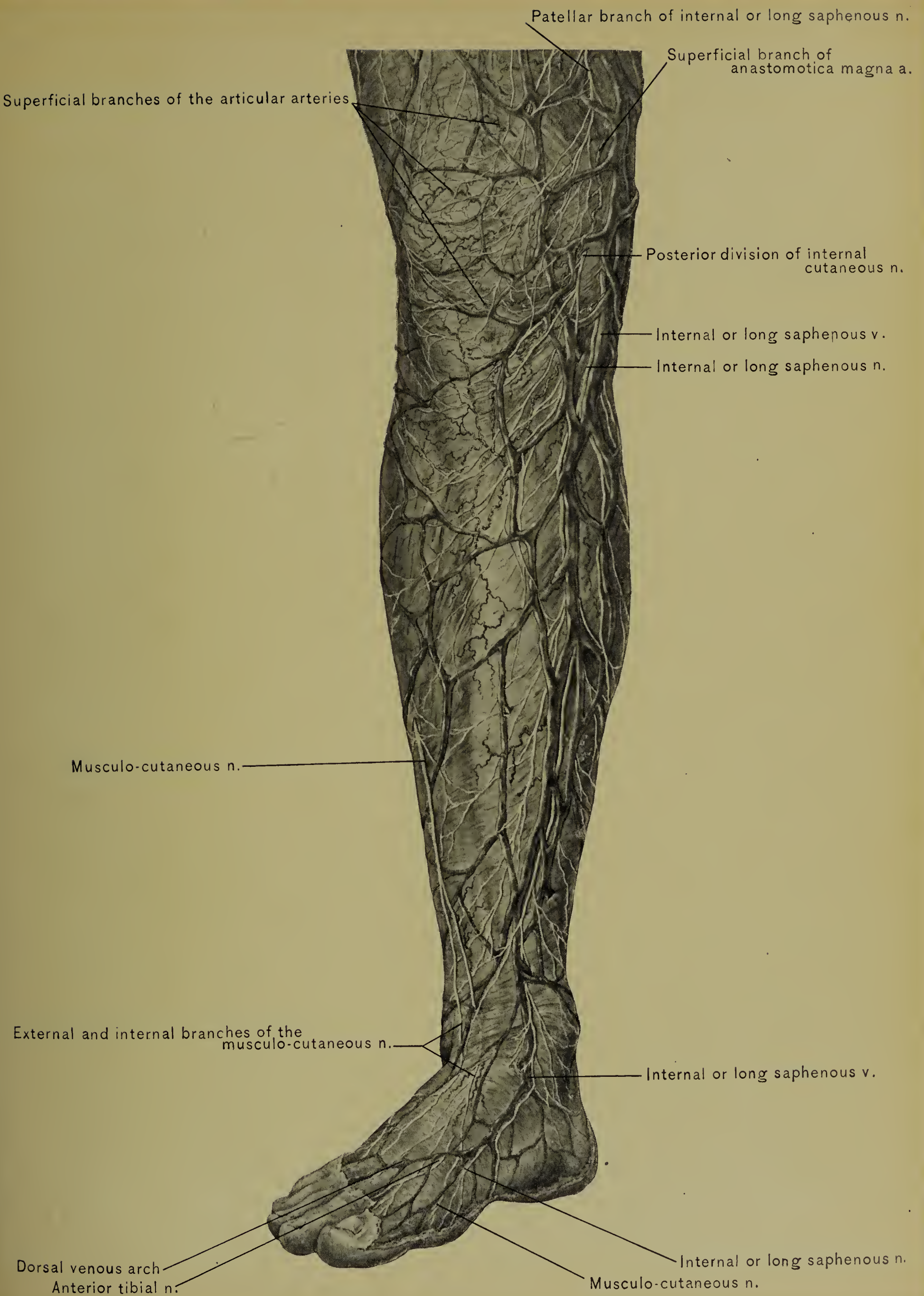
The **internal** or **long saphenous nerve**, a branch of the anterior crural, becomes superficial soon after passing between the tendons of the sartorius and gracilis. It passes down the inner side of the leg in close relation to the internal saphenous vein. It divides into two branches, one of which passes to the inner side of the ankle and the other in front of the internal malleolus, to be distributed to the inner side of the foot as far as the ball of the great toe. It sends off twigs to the skin in its course.

The **external** or **short saphenous nerve** in this stage of the dissection is seen emerging from behind the external malleolus and running along the outer side of the foot to the outer side of the little toe.

The remaining superficial nerves seen in this dissection are the musculo-cutaneous nerve, the internal terminal branch of the anterior tibial nerve, and branches of the external popliteal nerve. The **branch from the external popliteal nerve** supplies the skin over the upper part of the leg. The **musculo-cutaneous nerve** pierces the deep fascia at the junction of the middle and lower third of the leg as two branches, an inner and an outer. The *inner branch* passes downward to the dorsum of the foot; it divides into two terminal branches, one of which supplies the inner side of the great toe and the other the adjacent sides of the second and third toes. It also gives off branches which communicate with the **internal terminal branch of the anterior tibial nerve** and the nerve to the adjacent sides of the third and fourth toes. A small branch supplies the inner side of the ankle and foot and communicates with the long saphenous. The *outer branch* passes downward to the dorsum of the foot; it divides into three branches, one of which is joined by a filament from the inner branch and supplies the adjacent sides of the third and fourth toes; another supplies the adjacent sides of the fourth and fifth toes; and the remaining branch supplies the outer side of the foot and communicates with the external saphenous nerve.

DISSECTION.—The superficial fascia is reflected by making incisions similar to those made in reflecting the skin. The superficial nerves should be traced while removing this fascia. The deep fascia will now be exposed.

The **deep** or **crural fascia** forms a continuous layer around the leg and foot, except over the subcutaneous surface of the tibia, where it blends with the periosteum. Above, it is attached to the head of the tibia and fibula and is connected with the expanded tendons of the sartorius, gracilis, semitendinosus, and biceps muscles; it is also attached to the crest of the tibia. At the ankle it is strong and forms three bands,—the anterior, internal, and external annular ligaments,—beneath which pass the extensor and flexor



CUTANEOUS VESSELS AND NERVES OF FRONT OF LEG.

tendons, and the anterior and posterior tibial vessels and nerves. From the under surface of the fascia of the front of the leg muscular fibers arise, this being particularly the case just below the knee, where it is impossible to remove the fascia without removing some of the muscular fibers. From the deep surface of the fascia two intermuscular septa pass inward to be attached, one to the anterior and the other to the external border of the fibula. They serve to separate the peroneus longus and peroneus brevis muscles from the extensor muscles in front and the flexor muscles behind. In the upper third of the leg there is an additional intermuscular septum which separates the tibialis anticus and the extensor longus digitorum muscles. This septum is an important guide in the operation for ligation of the upper part of the anterior tibial artery. In this operation the dissection is made on the tibial side of this septum. In the back of the leg there is a septum or transverse layer of fascia which separates the soleus muscle from the flexor longus digitorum, flexor longus hallucis, and tibialis posticus muscles.

The **anterior annular ligament** extends across the front of the ankle-joint and binds down the extensor tendons of the ankle and toes. It consists of two portions, an upper and a lower. The upper portion is a strong, broad band attached externally to the lower end of the fibula, internally to the tibia, and above is continuous with the deep fascia of the leg. The lower portion is attached externally to the os calcis and cuboid, and internally divides into two portions, the upper of which is attached to the internal malleolus and the lower to the scaphoid, internal cuneiform, and plantar fascia. The upper portion of the ligament has two separate compartments. The internal compartment contains the tibialis anticus muscle; the external, the extensor longus digitorum and the peroneus tertius muscles. The lower portion of the ligament has three compartments: the internal contains the tendon of the tibialis anticus muscle; the middle, the tendon of the extensor proprius hallucis muscle; and the external, the tendons of the extensor longus digitorum and peroneus tertius muscles. As these tendons pass under the annular ligament, they are surrounded by synovial sheaths; hence teno-synovitis may occur here, just as on the dorsal surface of the wrist. The anterior tibial vessels and nerve, without possessing distinct sheaths, pass beneath both portions of the anterior annular ligament, while the internal saphenous vein and nerve and the musculo-cutaneous nerve pass over it.

The **internal annular ligament** is a dense band of fibers which extends from the internal malleolus to the os calcis, where it becomes continuous with the plantar fascia and tendinous portion of the abductor pollicis. It is continuous above with the deep fascia of the leg and the transverse layer of

fascia beneath the soleus. It binds down the flexor tendons of the foot and toes and forms three canals, through which these tendons pass, each canal being lined by a separate synovial sheath. These canals transmit, in the following order, from within outward, the tendons of the tibialis posticus, flexor longus digitorum, and flexor longus hallucis muscles. Beneath the ligament and between the tendons of the flexor longus digitorum and flexor longus hallucis pass the posterior tibial vessels and nerve; so that the order of the tendons, vessels, and nerve beneath the ligament, from within outward, is: the tendons of the tibialis posticus and flexor longus digitorum muscles; the posterior tibial artery and veins, the posterior tibial nerve, and the flexor longus hallucis tendon.

The **external annular ligament** extends from the external malleolus to the os calcis. It confines the tendons of the peroneus longus and brevis muscles, which are inclosed in a common synovial sheath.

Inflammation under the crural fascia.—Owing to the density of the deep fascia of the leg, sloughing or gangrene develops early in inflammation of this part, attended by excessive effusion, or in cases of great extravasation of blood following a wound of one of the deep vessels. A collection of pus beneath the deep fascia, if not evacuated early, will burrow extensively.

DISSECTION.—Remove the deep fascia as far down as the anterior annular ligament, making an incision through it along the outer border of the subcutaneous surface of the tibia. In taking off this fascia be careful to remove as little of the muscular fiber with it as possible, and not to cut the musculocutaneous nerve, which pierces it on the outer aspect of the leg, at the junction of the middle with the lower third. This will expose the muscles on the front and outer side of the leg: viz., the tibialis anticus, extensor longus digitorum, extensor proprius hallucis, peroneus tertius, peroneus longus and brevis.

The **tibialis anticus muscle** is situated immediately to the outer side of the tibia. It arises from the outer tuberosity and upper two-thirds of the outer surface of the shaft of the tibia, from the interosseous membrane, from the deep fascia covering the muscle, and from the intermuscular septum between it and the extensor longus digitorum muscle. At the lower third of the leg the fibers terminate in a flat tendon which passes obliquely over the front of the ankle through the innermost compartment of the anterior annular ligament, to the inner side of the foot, where it is inserted into the internal cuneiform and base of the metatarsal bone of the great toe. The tibialis anticus muscle lies at first to the outer side of the tibia. It rests, from above downward, on the interosseous membrane, the lower end of the tibia, the ankle-joint, and the scaphoid bone. To its outer side are the anterior tibial vessels and nerve

and the extensor longus digitorum and extensor proprius hallucis muscles. The anterior tibial vessels and nerve are concealed by the muscles in the upper part of the leg.

NERVE SUPPLY.—Its nerve supply is derived from the anterior tibial.

ACTION.—The action of the tibialis anticus is to draw the foot upward and inward and to slightly invert the sole. Its contraction favors the deformity known as talipes varus.

The **extensor longus digitorum muscle** lies to the fibular side of the tibialis anticus. It arises from the outer tuberosity of the tibia, from the upper three-fourths of the shaft of the fibula, from the interosseous membrane, from the deep fascia, and from the intermuscular septa, separating it from the tibialis anticus on the inner, and the peronei muscles on the outer side. Its fibers terminate in a tendon which passes in front of the ankle through the external compartment of both portions of the anterior annular ligament and divides into four slips. Below the ligament these slips are continued to the four outer toes and are inserted into the bases of the phalanges. Each tendon opposite the metatarso-phalangeal joint is joined on its outer side by the tendon of the extensor brevis digitorum and by a fibrous expansion from the interossei and lumbricales to form an aponeurosis which covers the dorsal surface of the first phalanx. This aponeurosis gives off processes to the lateral ligaments of the metatarso-phalangeal joints and divides into three slips opposite the joint between the first and second phalanges; the middle slip is inserted into the base of the second phalanx, while the two lateral unite on the dorsal surface of the second phalanx and are continued forward to be inserted into the base of the third phalanx. The arrangement of the extensor tendons of the toes is similar to that of the fingers. This muscle lies between the tibialis anticus and the peroneus longus. The anterior tibial vessels and nerve and the extensor proprius hallucis and tibialis anticus muscles are to its inner side, the peronei muscles and the musculo-cutaneous nerve to its outer side. It lies on the fibula, the interosseous membrane, and the ankle-joint. Its tendons rest on the extensor brevis digitorum muscle and on the tarsus and metatarsus. The innermost tendon of the extensor longus digitorum muscle is a guide in the ligation of the dorsalis pedis artery.

NERVE SUPPLY.—Its nerve supply is from the anterior tibial nerve.

ACTION.—The muscle is an extensor of the four outer toes and a flexor of the ankle-joint.

The **peroneus tertius** is a small muscle and may be considered a part of the extensor longus digitorum. It arises from the lower fourth of the anterior surface of the shaft of the fibula, from the interosseous membrane, and from the inter-

muscular septum between it and the peroneus brevis. Its tendon passes through the same canal in the annular ligament as the extensor longus digitorum and is inserted into the inner side of the dorsal surface of the base of the metatarsal bone of the little toe.

NERVE SUPPLY.—The nerve supply of the peroneus tertius is derived from the anterior tibial.

ACTION.—It draws the outer border of the foot upward, everting the sole, and assists the tibialis anticus and extensor longus digitorum in flexing the ankle.

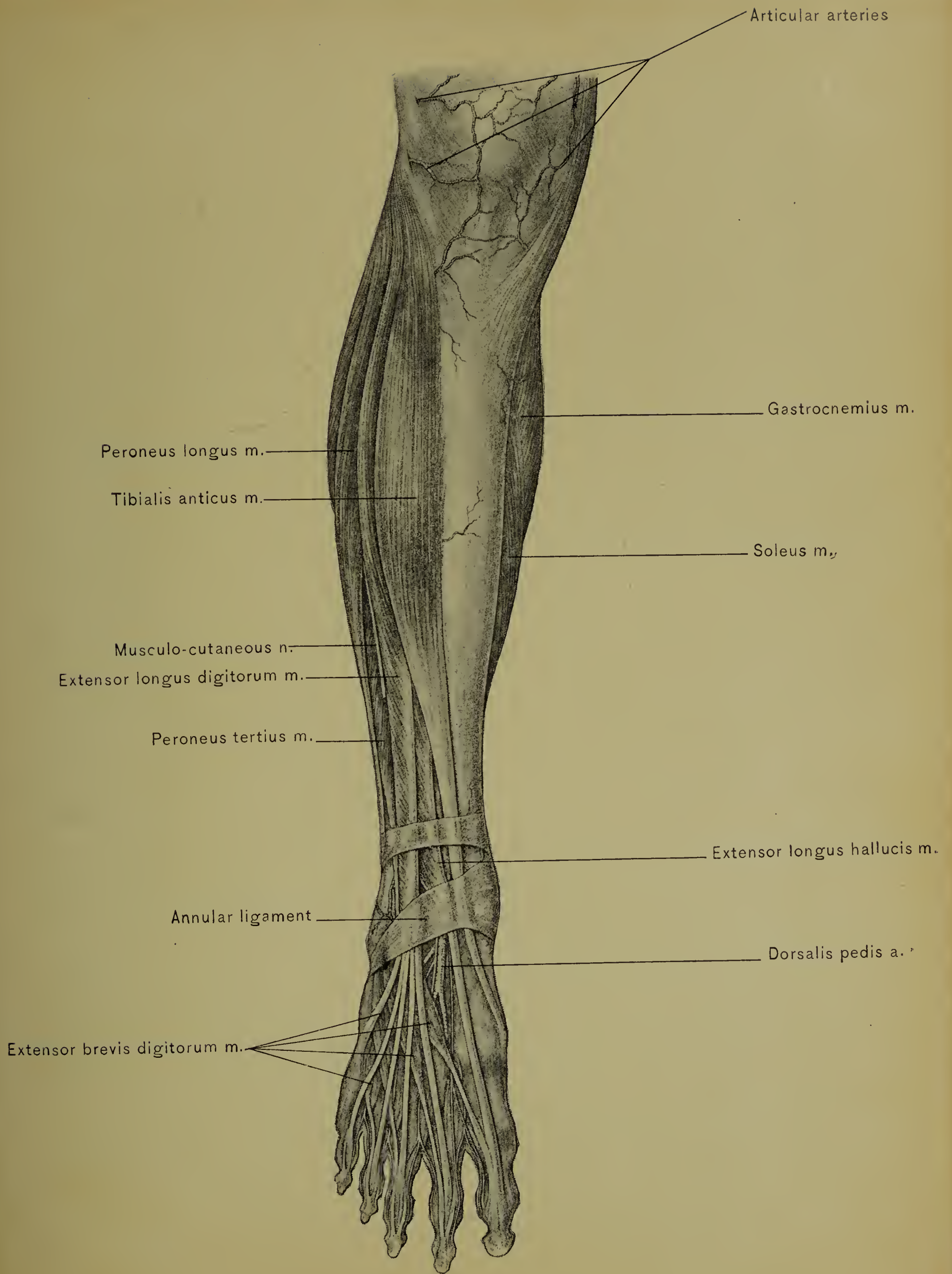
The **extensor proprius hallucis muscle** at its origin is deeply seated between the tibialis anticus and the extensor longus digitorum. At the lower portion of the leg it becomes superficial. It arises from the anterior surface of the middle two fourths of the shaft of the fibula and interosseous membrane. Its fibers terminate in a tendon which passes beneath the upper portion of the anterior annular ligament over the ankle and through the middle compartment of the lower portion of the ligament between the tendons of the tibialis anticus and extensor longus digitorum. Thence it passes along the dorsum of the foot to be inserted into the base of the last phalanx of the great toe. Opposite the metatarso-phalangeal joint a small slip from either side of the tendon is attached to the lateral ligaments and the sides of the base of the first phalanx. Above the ankle the tendon crosses the anterior tibial vessels and nerve to their inner side. To the inner side of this muscle in the leg are the tibialis anticus muscle and the anterior tibial vessels and nerve; to its outer side, above, is the extensor longus digitorum muscle, and below, near the ankle, are the anterior tibial vessels and nerve. It rests on the interosseous membrane, the tibia, and the anterior tibial vessels and nerve; on the dorsum of the foot, to the inner side of its tendon, is the tendon of the tibialis anticus, to the outer side are the dorsalis pedis vessels and anterior tibial nerve and the innermost tendon of the extensor brevis digitorum.

NERVE SUPPLY.—The nerve supply is derived from the anterior tibial.

ACTION.—It extends the great toe, assists in flexing the ankle-joint, and assists in inverting the sole of the foot.

The anterior tibial group of muscles is often paralyzed as the result of anterior poliomyelitis in young children. The foot under these circumstances cannot be flexed on the leg, and assumes the extended position; the muscles become markedly atrophied. From the contracture of the calf muscles, talipes equinus may then follow.

The **anterior tibial artery**, the smaller of the two terminal branches of the popliteal, reaches the front of the leg about an inch and a quarter (3.8 centimeters) below the head of the fibula by passing between the two heads of the tibialis posticus muscle and above the upper border of the interosseous membrane. It



then descends, in the upper two-thirds of its course lying upon the interosseous membrane, and lower down along the front of the tibia. It passes in front of the ankle beneath the anterior annular ligament, at the lower border of which it becomes the *dorsalis pedis*. A line drawn from a point midway between the head of the fibula and the tubercle of the tibia to a point midway between the two malleoli in front will indicate the course of this artery.

RELATIONS OF THE ANTERIOR TIBIAL ARTERY.—In the upper third of the leg it lies between the *tibialis anticus* and the *extensor longus digitorum* muscles; in the middle third, between the *tibialis anticus* and the *extensor proprius hallucis* muscles; in the lower third and in front of the ankle it is crossed by the tendon of the *extensor proprius hallucis* muscle and lies between it and the *extensor longus digitorum* tendon. It is accompanied by two veins, the *venæ comites*, and by the anterior tibial nerve. At the upper third of the leg the nerve lies to the outer side of the artery; in the middle third, in front of the artery; and at the lower third, again to the outer side of the artery. Ligation of the anterior tibial is more difficult in the upper third than in either the middle or the lower third of the leg, owing to the distance it lies from the surface.

Injuries of the anterior tibial artery.—In fracture of both bones of the leg, or of the tibia alone, either the anterior tibial or the posterior tibial artery may be injured. A periosteal growth, most commonly sarcoma, involving either of the bones of the leg, may also include the anterior tibial artery, and under such circumstances the vessel would be liable to injury should the growth be excised. I recall one case of periosteal sarcoma of the upper part of the fibula which by extending inward involved the anterior tibial artery and necessitated the division of the vessel above and below the growth on its removal. The anterior tibial nerve was not involved in this case. It is readily understood why the nerve escapes when its relations in the upper part of the leg are recalled. The closer to the interosseous membrane the anterior tibial artery is cut, the more difficult it is to ligate it. Hemorrhage from a stab wound of the front of the leg does not necessarily mean that the anterior tibial has been cut. The weapon may have passed between the bones through the interosseous membrane and wounded a vessel behind the latter structure.

The branches of the anterior tibial artery are, from above downward: the posterior recurrent tibial, superior fibular, anterior recurrent tibial, muscular, and internal and external malleolar.

The *posterior recurrent tibial artery*, when present, arises from the anterior tibial artery on the back of the leg and ascends beneath the *popliteus* muscle. It supplies the *popliteus*, the knee, and the superior tibio-fibular joints, and anastomoses with the inferior articular branches of the *popliteal*.

The *superior fibular branch* arises from the anterior tibial, sometimes from the posterior tibial, passes through the outer head of the soleus muscle, winds around the neck of the fibula, and terminates in the peroneus longus muscle.

The *recurrent tibial artery* arises from the anterior tibial immediately after it has reached the anterior part of the leg; it ascends through the tibialis anticus muscle to the front of the knee-joint, and anastomoses with the articular branches of the popliteal, and with the anastomotica magna branch of the femoral artery.

The *muscular branches* are distributed to the muscles on either side of the artery. Some pierce the deep fascia and supply the integument. Others pierce the interosseous membrane, and, after reaching the posterior part of the leg, anastomose with branches of the posterior tibial and peroneal arteries.

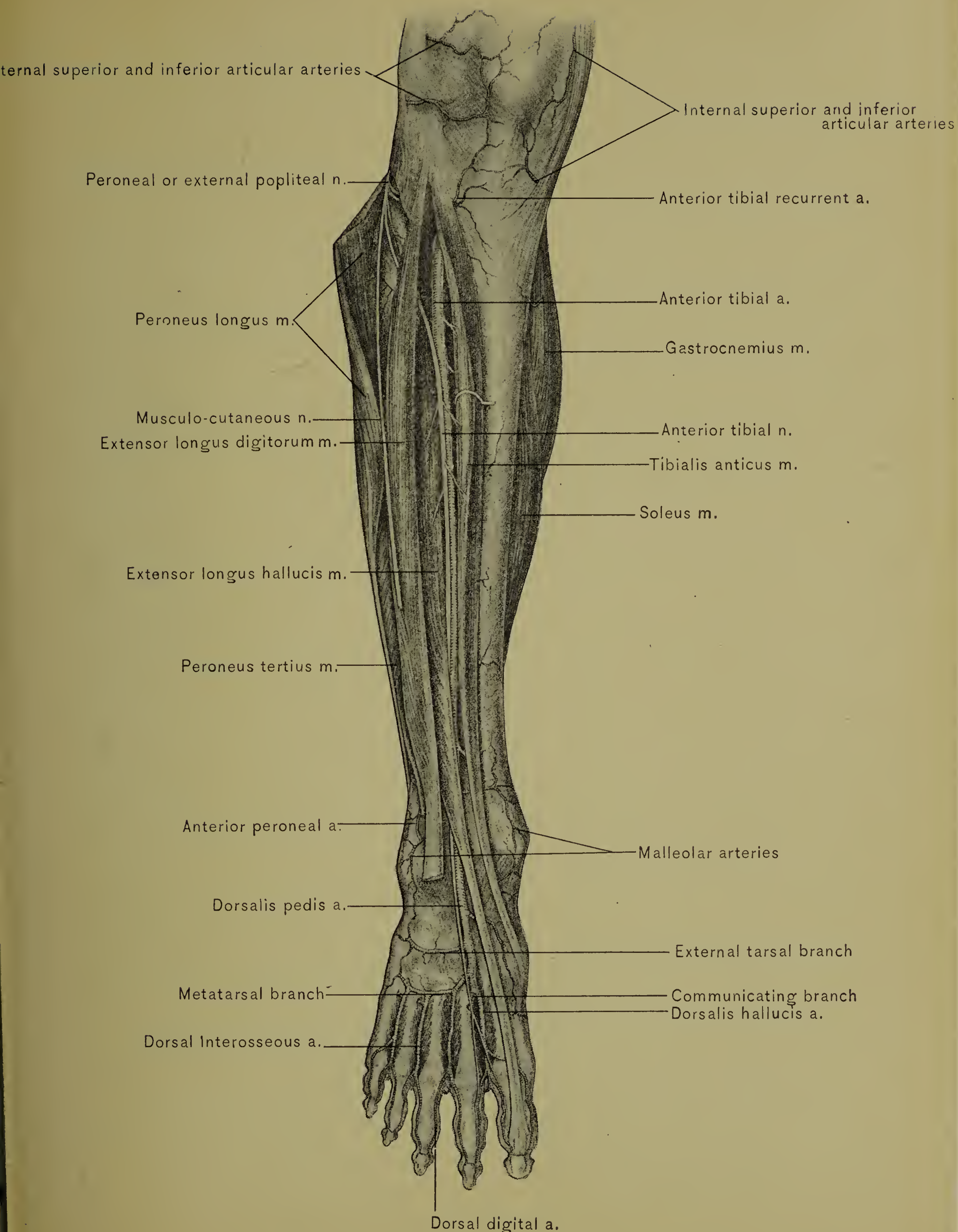
The *malleolar arteries*, two in number, the internal and external, arise from the anterior tibial above the ankle-joint. The *internal malleolar artery* arises about two inches (5.0 centimeters) above the ankle and passes downward and inward beneath the tendons of the extensor proprius hallucis and tibialis anticus muscles to the internal malleolus, at the lower margin of which it divides into branches that anastomose with the internal plantar artery and the internal calcanean branch of the posterior tibial artery. The *external malleolar artery*, the larger of the two, arises lower than the internal, passes downward and outward beneath the tendons of the extensor longus digitorum and peroneus tertius muscles, to reach the anterior part of the external malleolus, where it anastomoses with the anterior peroneal artery, and the tarsal branch of the dorsalis pedis artery.

In addition to the above-named branches, small articular twigs arise from the anterior tibial artery at the ankle, to supply the ankle-joint.

The **anterior peroneal artery** arises from the peroneal and pierces the interosseous membrane about two inches (5.0 centimeters) above the external malleolus. It emerges from under the peroneus tertius muscle and passes over the external malleolus and the outer side of the tarsus. It anastomoses with the external malleolar and tarsal arteries.

The Peroneus Longus and Brevis Muscles.—Upon the outer side of the leg, separated from the muscles upon the anterior part by a strong intermuscular septum of the deep fascia, are the peroneus longus and peroneus brevis muscles.

The **peroneus longus**, the more superficial, is situated at the upper part of the outer side of the leg. It arises from the head and outer surface of the upper two-thirds of the shaft of the fibula, from the outer tuberosity of the tibia, from the deep fascia which covers it, and from the intermuscular septa between it and the muscles on the front and back of the leg. The fibers



ANTERIOR TIBIAL ARTERY AND NERVE, DORSALIS PEDIS ARTERY AND MUSCULO-CUTANEOUS NERVE.

terminate in a long tendon which passes beneath the external annular ligament behind the external malleolus, in a groove common to it and the peroneus brevis. It then passes along the outer side of the os calcis, surrounded by a separate fibrous sheath. After reaching the outer side of the cuboid it turns into the sole of the foot, across which it runs in a groove on the under surface of the cuboid. This groove is converted into a canal by the long calcaneo-cuboid ligament. The tendon is inserted into the outer side of the base of the metatarsal bone of the great toe and the internal cuneiform. Where the tendon rests against the outer side of the cuboid it often contains a sesamoid bone or cartilage. The tendons of the peroneus longus and brevis possess a common synovial sheath behind the external malleolus which divides to envelop the tendons separately on the outer side of the os calcis. The tendon of the peroneus longus has another synovial sheath in the sole of the foot. In the operation for removal of the metatarsal bone of the great toe, when possible the attachment of the tendon of the peroneus longus muscle should be left undisturbed. Between the peroneus longus and the neck of the fibula is the peroneal or external popliteal nerve. Running through its substance, and between it and the peroneus brevis, is the musculo-cutaneous nerve. The peroneus longus muscle lies between the two strong intermuscular septa which separate it from the extensors in front and the flexors behind.

The **peroneus brevis muscle** lies beneath the peroneus longus, and is smaller than the latter. It arises from the lower two-thirds of the outer surface of the shaft of the fibula, in front of the peroneus longus, and from the intermuscular septa between it and the muscles on the front and back of the leg. Its fibers terminate in a tendon which passes beneath the external annular ligament and through the groove behind the external malleolus common to it and the peroneus longus, in this situation lying in front of the tendon of the peroneus longus. It then passes along the outer side of the os calcis above the tendon of the peroneus longus muscle in a separate sheath, and is inserted into the outer side of the dorsal surface of the base of the metatarsal bone of the little toe. In the leg it lies beneath the peroneus longus, upon the fibula, and between the intermuscular septa, separating it from the muscles on the front and back of the leg. Between it and the peroneus longus in the leg is the musculo-cutaneous nerve.

NERVE SUPPLY.—The nerve supply of both muscles is derived from the musculo-cutaneous nerve.

ACTION.—The action of the peronei muscles is to evert, to assist in extension of, and to abduct the anterior portion of the foot. In the form of club-foot known as talipes valgus these tendons require division.

Traumatic displacement in a forward direction of the tendons of the peroneus longus and brevis from their grooves behind the malleolus may be met with; in such a case the tendons will become prominent under the integument and the patient will suffer from pain and lameness.

DISSECTION.—Reflect the upper part of the peroneus longus muscle, when the external popliteal or peroneal nerve will be seen dividing into its two terminal branches.

The External Popliteal or Peroneal Nerve.—Immediately below the head of the fibula, between the neck of the bone and the peroneus longus muscle, the external popliteal nerve gives off the recurrent articular nerve, and divides into the anterior tibial and musculo-cutaneous nerves.

The **recurrent articular nerve** is largely distributed to the tibialis anticus muscle. Some of its fibers accompany the anterior recurrent tibial artery to the front of the knee-joint. It also gives off articular and cutaneous branches which will be described with the back of the leg.

The **anterior tibial nerve** pierces the extensor longus digitorum muscle and accompanies the anterior tibial artery, as already described. It supplies the tibialis anticus, extensor longus digitorum, extensor proprius hallucis, peroneus tertius, and extensor brevis digitorum muscles and sends a small articular branch to the ankle-joint. It also supplies the adjacent sides of the dorsal surface of the great and second toes.

The **musculo-cutaneous nerve** passes forward and downward through the substance of the peroneus longus muscle, then between the peroneus longus and brevis muscles, and lastly between the peroneus brevis and the extensor longus digitorum muscles, where it divides into two branches, an inner and an outer. These two branches pierce the deep fascia at the junction of the middle with the lower third of the leg to reach the superficial fascia, as already described. The musculo-cutaneous nerve supplies the peroneus longus and brevis muscles. It also supplies the inner side of the great toe and adjacent sides of the second and third and of the third and fourth toes on the dorsal surface. In a lean subject with the foot in the position of strong adduction, this nerve can often be seen as a subcutaneous cord, and should not be mistaken for a tendon.

Injuries of the Nerves.—These nerves, like the blood-vessels, are liable to injury in fracture and wounds. Division of the external popliteal or peroneal nerve, or of any sensori-motor nerve, of course results in paralysis of the parts supplied by the same. I have sutured a divided external popliteal nerve one and one-half years after the injury, and had complete restoration of the function of the limb.

Pressur  upon the peroneal nerve, and neuritis, lead to paralysis of the

muscles supplied by it, and "foot-drop" occurs. When the patient attempts to walk, the great toe is stubbed against the ground, and in order to prevent this he will raise the entire leg, thus producing an appearance as though he were stepping over obstacles (*steppage gait*).

THE DORSUM OF THE FOOT.

The **deep fascia** covering the dorsum of the foot is a thin membranous layer continuous above with the lower margin of the anterior annular ligament, and on each side with the lateral portions of the plantar fascia. It extends forward to the toes.

DISSECTION.—Remove this fascia and expose the muscles, tendons, vessels, and the anterior tibial nerve. The tendons of the extensor longus digitorum and peroneus tertius muscles should be cut through just below the annular ligament, and reflected toward the toes; the extensor brevis digitorum muscle can then be examined.

The **extensor brevis digitorum** is a broad thin muscle which arises from the front and outer surface of the os calcis anterior to the groove for the peroneus brevis muscle, from the external calcaneo-astragaloid ligament, and from the anterior annular ligament. It passes forward and inward as four bellies to terminate in four tendons which are attached to the four inner toes. The inner tendon, the largest, crosses the dorsalis pedis artery, and, becoming expanded, is inserted into the base of the first phalanx of the great toe; the remaining three join the fibular side of the long extensor tendons to be inserted with them into the bases of the second and last phalanges. The muscle lies beneath the tendons of the extensor longus digitorum and peroneus tertius muscles. Its inner belly is a guide in finding the dorsalis pedis artery.

NERVE SUPPLY.—The nerve supply is from the anterior tibial.

ACTION.—Its action is to assist the long extensor tendons in extending the four inner toes, as well as to draw them toward the fibular side.

The **dorsalis pedis artery**, the continuation of the anterior tibial, runs over the instep to the interval between the first and second metatarsal bones, where it divides into two terminal branches, the dorsalis hallucis and the communicating. A line drawn from the center of the intermalleolar space in front to a point midway between the great and second toes will represent its course. The artery lies upon the astragalus, the scaphoid, and the internal cuneiform bones, but separated from them by their dorsal ligaments. It is covered by skin, superficial and deep fascia, and the inner margin of the extensor brevis digitorum muscle, and is crossed by the innermost tendon of this muscle. It lies between the tendons of the exten-

sor proprius hallucis on its inner side, and the innermost tendon of the extensor longus digitorum and the inner belly of the extensor brevis digitorum on its outer side. It is accompanied by two veins and the anterior tibial nerve, which lies to its outer side. In cases where the dorsalis pedis artery is absent, its place is supplied by the anterior peroneal branch of the peroneal artery.

The **branches of the dorsalis pedis artery** are the tarsal, the metatarsal, the dorsalis hallucis, and the communicating.

The *tarsal branch* arises opposite the scaphoid bone and passes outward in an arched direction beneath the extensor brevis digitorum muscle toward the outer side of the foot, supplying this muscle, the bones, and the joints of the tarsus. It anastomoses with the metatarsal, the external malleolar, the anterior peroneal, and the external plantar arteries.

The *metatarsal branch* forms the dorsal arch of the foot. It passes outward beneath the tendons of the extensor brevis digitorum near the bases of the metatarsal bones, and, reaching the outer side of the foot, anastomoses with the tarsal and external plantar arteries. Its branches are the dorsal interosseous arteries.

The metatarsal artery gives off three outer *dorsal interosseous arteries*, which pass forward upon the three outer dorsal interossei muscles, which they supply. At the clefts of the toes each divides into two branches for the supply of the adjacent sides of the second, third, fourth, and fifth toes, the outermost interosseous giving off a small twig to supply the outer side of the little toe. At the proximal part of the interosseous spaces they are joined by the posterior perforating branches of the plantar arch, and at the distal part they receive the anterior perforating branches from the digital arteries.

The two succeeding vessels are the *terminal divisions of the dorsalis pedis*, the dorsalis hallucis being the apparent continuation of the primary trunk.

The *dorsalis hallucis artery* extends forward over the first interosseous space, and at the cleft between the first and second toes divides into two branches. One of these passes beneath the tendon of the extensor proprius hallucis muscle to be distributed to the inner side of the great toe; the other divides into two branches to supply the adjacent sides of the great and second toes.

The *communicating artery* passes into the sole of the foot between the two heads of the first dorsal interosseous muscle and anastomoses with the terminal portion of the external plantar artery, thereby completing the plantar arch. The relation which this vessel bears to the first dorsal interosseous muscle of the foot is similar to that borne by the radial artery to the first dorsal interosseous muscle of the hand.

THE BUTTOCKS.

Place the body face downward with a block under the pelvis, and rotate the thigh inward. Carry an incision along the whole length of the crest of the ilium, over the middle of the sacrum to the tip of the coccyx, then obliquely forward to the incision on the inner side of the thigh. Reflect the skin downward and outward.

The skin of the buttock is thick and coarse and is but slightly movable on the underlying parts. Its blood supply is not so free as in other parts of the surface of the body.

The superficial fascia now exposed is loosely attached and contains a large quantity of fat. Owing to the comparatively large amount of fat, the buttocks are a favorable locality for lipomata. Over the tuberosity of the ischium the adipose tissue is thicker and denser than elsewhere and forms a cushion beneath which a bursa is frequently found. It is due to the fat contained in the superficial fascia, rather than to the muscular development, that the buttock is round and prominent; this is especially the case in women. Flattening of the buttocks, an early symptom of hip-joint disease, is not due to the absorption of the fat and atrophy of the muscles, as stated in some books, but to the flexion of the hip. The looseness of the superficial fascia permits large effusion to take place in this region, so that in contusions of the buttock the ecchymosis is more pronounced than in contusions of other portions of the body.

The **cutaneous nerves of the buttocks**, from before backward, are as follows:

Branches from the external cutaneous nerve are distributed over the great trochanter.

Branches from the small sciatic nerve wind around the lower border of the gluteus maximus and supply the skin and fascia over the lower part of this muscle. The *perforating cutaneous branch* of the fourth sacral nerve also supplies the lower portion of the gluteal cutaneous surface, and, after piercing the great sacro-sciatic ligament, and winding around the lower border of the gluteus maximus muscle, usually appears external to the ischial tuberosity.

Passing over the crest of the ilium a short distance behind the anterior superior spinous process of the ilium is the *lateral cutaneous branch of the last dorsal nerve*, which is distributed to the skin and fascia, some of its filaments extending as low as the great trochanter.

Behind the last-named branch, and crossing the crest of the ilium a little in advance of its middle, is the *iliac branch of the ilio-hypogastric nerve*.

Passing over the posterior part of the crest of the ilium are *cutaneous branches of the posterior divisions of the upper three lumbar nerves*.

Cutaneous filaments from the external branches of the posterior divisions of the three upper sacral nerves pierce the gluteus maximus muscle near its origin and supply the skin and fascia over the extreme posterior part of the gluteal region.

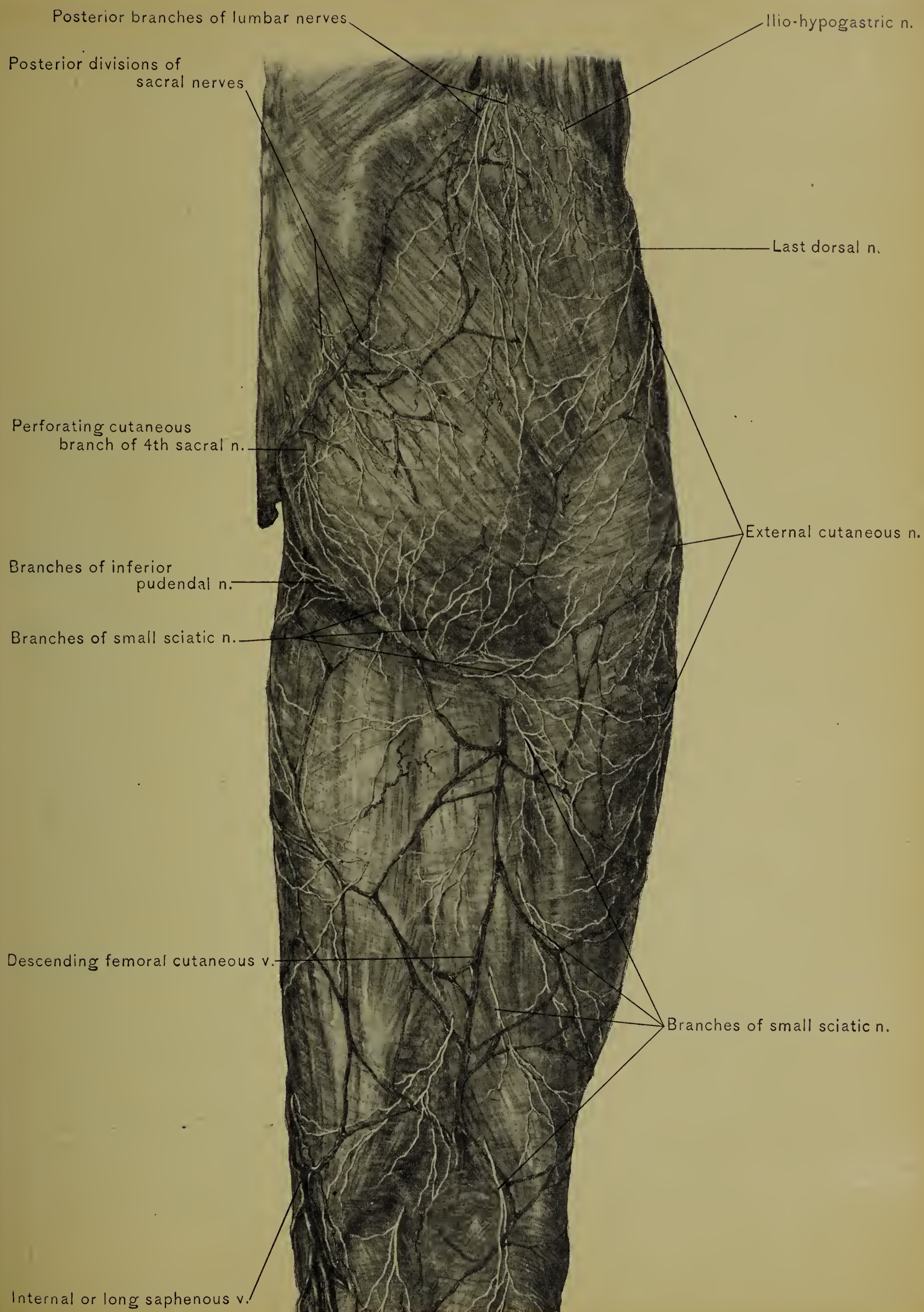
The cutaneous vessels in the gluteal region are branches of the gluteal, the sciatic, and the external circumflex arteries.

DISSECTION.—Reflect the superficial fascia by making an incision similar to that made in reflecting the skin.

The deep fascia of the buttock, or gluteal fascia, a very important structure, is continuous with the deep fascia of the thigh, and near the coccyx with the anal fascia. It is attached above to the crest of the ilium and behind to the sacrum, coccyx, and great sacro-sciatic ligament. It is much thicker in front, where it covers the gluteus medius muscle, than behind, where it covers the gluteus maximus; in the latter situation it is comparatively thin. At the anterior border of the gluteus maximus the deep fascia divides into two layers, the superficial layer covering the upper surface of the muscle, the deep layer covering its under surface, thus incasing the muscle.

The superficial layer of the gluteal fascia, in passing over the gluteus maximus muscle, sends septa into the muscle to incase bundles of fibers. It is on account of these septa that the muscle is so hard to clean and presents a coarse appearance.

Extravasations of blood beneath this fascia will not discolor the skin and may be mistaken for abscess. Deep inflammation beneath this fascia, and, especially, when beneath the gluteus medius, may be associated with much pain, owing to the inflammatory effusions being held between a wall of bone on one side and strong fascia and thick muscles on the other. Pus so confined may travel a considerable distance down the thigh before it reaches the surface. Farabeuf relates a case where a gluteal abscess traveled to the ankle before it broke (Treves). Under other circumstances the pus may find its way into the pelvis through the sciatic foramina, while, too, a pelvic abscess may escape through one of these foramina and form a deep collection in the buttock. The ilio-tibial band, which has been described with the fascia lata of the thigh, is tightly stretched across the gap between the crest of the ilium and the great trochanter. By making pressure on the fascia between these bony points, the amount of resistance it is capable of offering can be readily appreciated. In fracture of the neck of the femur, when the great trochanter is made to approach nearer to the crest of the ilium, this band will be relaxed. This fact was pointed out by Dr. Allis, who has drawn attention to this relaxation of the fascia as of value in the diagnosis of fracture of the neck of the femur.



CUTANEOUS VESSELS AND NERVES OF THE BACK OF THE LOWER EXTREMITY.

DISSECTION.—The superficial layer of the deep fascia is now to be removed. This requires care in order not to remove with it a portion of the gluteus maximus muscle, the latter being the most difficult muscle in the body to clean. By keeping the fascia wet with a dampened sponge, and cutting across the line of the fibers of the muscle, the gluteus maximus can be cleaned very nicely.

The **Muscles of the Gluteal Region** are the gluteus maximus, gluteus medius, gluteus minimus, piriformis, gemellus superior, obturator internus, gemellus inferior, obturator externus, and quadratus femoris.

The **gluteus maximus** is the largest muscle of the body and the most superficial one of the buttock. It arises from the posterior fourth of the crest of the ilium, the rough surface of the ilium immediately below, from the lumbar aponeurosis at its attachment to the crest of the ilium, from the posterior surface of the fourth and fifth pieces of the sacrum, from the coccyx, from the fascia covering the gluteus medius muscle, and from the great sacro-sciatic ligament. The fibers pass obliquely downward, outward, and forward. The anterior two-thirds of the muscle is inserted into the deep fascia on the outer side of the thigh (ilio-tibial band); the posterior and lower third is inserted into the gluteal ridge, the rough line of the femur leading from the great trochanter to the linea aspera, between the vastus externus and the adductor magnus.

Bursæ beneath the gluteus maximus.—There are three bursæ beneath the gluteus maximus muscle: one between the muscle and the tuberosity of the ischium; another between the fascial insertion and the great trochanter; and a third between the bony insertion and the vastus externus muscle. Of these, the one between the fascial insertion and the great trochanter, which is multilocular, is the most important. When it is inflamed, much pain is experienced in moving the limb, the thigh being generally in the position of flexion and abduction. Caries of the great trochanter has been seen to follow suppuration of this bursa, owing to its close relation to the bone (Teale). To the inexperienced observer, inflammation of this bursa may be mistaken for hip disease; but if it be noted that there is an absence of swelling of the joint, and that the head of the femur can be rotated in the acetabulum without exciting pain, in addition to the presence of swelling and tenderness over the site of the bursa, the mistake should not occur. The bursæ over the tuberosity of the ischium may become inflamed in those who sit a great deal, such as coachmen, weavers, etc., as it is pressed upon in the sitting posture. When enlarged, it constitutes the disease formerly named “weaver’s bottom,” and may cause pain from pressure upon the inferior pudendal nerve.

The gluteus maximus muscle, from its situation forming the prominence of the buttock, from its coarseness, and from the fact that it protects the

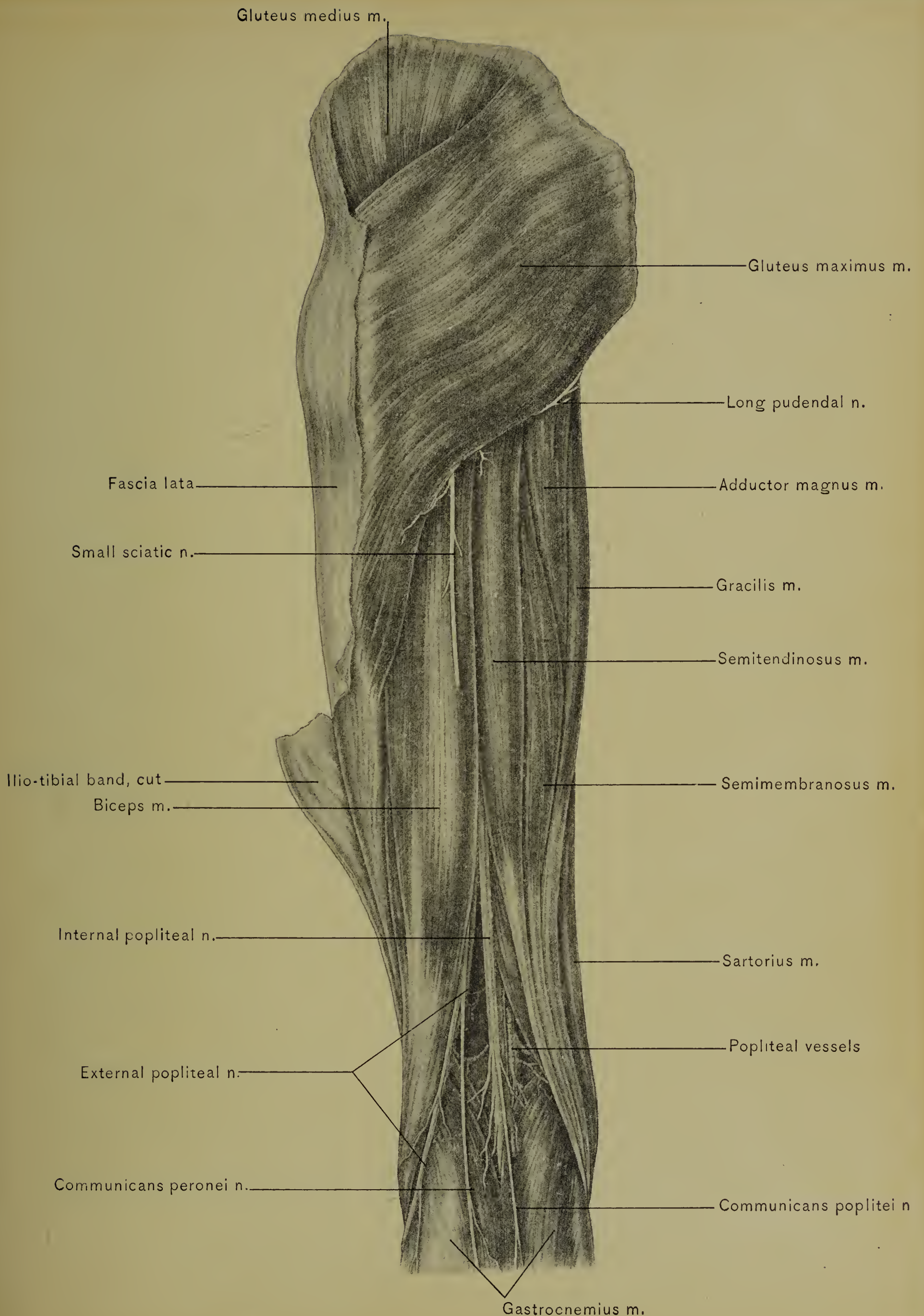
hip-joint and passes over the larger of the two trochanters, may be likened to the deltoid muscle, which is also coarse, and covers the shoulder-joint and the greater tuberosity of the humerus. The upper border overlies the gluteus medius, while the lower, much the thicker and longer, bounds the ischio-rectal fossa and extends obliquely across the back of the thigh over the flexor muscles. Beneath the lower border pass the sciatic vessels and nerves. In the extended position of the femur the gluteus maximus muscle covers the tuber ischii; when the limb is flexed on the pelvis, the tuberosity is uncovered by the muscle. Superficially it is in relation with the fat of the buttock and with the superficial nerves. Deeply, with the gluteus medius, pyriformis, gemelli and obturator internus, quadratus femoris, adductor magnus, biceps, semitendinosus and semimembranosus muscles; the gluteal, sciatic, and pudic vessels, the great and small sciatic nerves, the nerve to the obturator internus muscle and the pudic nerve, the sacro-sciatic ligaments, the tuber ischii, and the great trochanter.

R. Guiteras ("Annals of Surgery," vol. xxii, p. 311) has described a space which he calls the "*subgluteal triangle*." It is bounded externally by the line of attachment of the gluteus maximus to the femur and by the great trochanter, internally by the long head of the biceps, tuber ischii, and part of the great sacro-sciatic ligament, and above by the pyriformis. Its floor is formed by the gemellus superior and inferior, the obturator, quadratus femoris, and adductor magnus muscles. The contents are the greater and lesser sciatic nerves, the internal pudic nerve and the nerve to the obturator internus muscle, the sciatic and internal pudic arteries and branches of the profunda femoris artery, together with fatty tissue, lymphatics, and bursæ. All these parts are covered by the gluteus maximus muscle.

NERVE SUPPLY.—It is supplied by the inferior gluteal nerve and by branches of the small sciatic nerve.

ACTION.—The gluteus maximus muscle acts as an extensor, an external rotator and abductor of the thigh, and also as a tensor of the fascia lata. In extending the thigh it assists in raising the body from the sitting to the standing posture, and, while in the latter position, steadies the knee-joint by making tense the ilio-tibial band, in which action it is assisted by the tensor fasciæ femoris.

DISSECTION.—Cut through the muscle near its origin until the layer of fascia lining its under surface, a guide in its removal, is reached. Reflect it with the layer of fascia downward and outward, tracing the vessels and nerves which enter its under surface. They are the inferior gluteal vessels and nerve, and branches of the superior gluteal and sciatic vessels. Remove the areolar tissue and fat from the area covered by the muscle, when the following structures will be exposed:



GLUTEUS MAXIMUS AND FLEXORS.

The posterior portion of the gluteus medius muscle, below which is the pyriformis. Emerging from between the pyriformis and gluteus medius, is seen the gluteal artery; from beneath the pyriformis, the great and small sciatic nerves, the sciatic vessels, and the inferior gluteal nerve make their appearance. Besides the above-mentioned structures are seen the branch of the sciatic artery accompanying the great sciatic nerve; winding over the spine of the ischium, the internal pudic vessels, the pudic nerve, and the nerve to the obturator internus muscle; the tendon of the obturator internus muscle between the superior and inferior gemellus muscles; the quadratus femoris muscle and the upper border of the adductor magnus, with the terminal branch of the internal circumflex artery passing between them; the origin of the semimembranosus, biceps, and semitendinosus muscles; the great trochanter and the overlying bursa, a small part of the vastus externus muscle, the tuberosity of the ischium with its bursæ, the great sacro-sciatic ligament, pierced by the coccygeal branch of the sciatic artery and the perforating cutaneous branch of the fourth sacral nerve; the coccyx, the side of the sacrum, and the posterior part of the crest of the ilium with the rough surface of bone beneath. The gluteal artery, the superior and inferior gluteal nerves, the pyriformis muscle, the great and small sciatic nerves, the sciatic artery, the pudic artery and nerve, the nerve to the obturator internus, and the nerve to the quadratus femoris come out of the pelvis through the great sacro-sciatic foramen. The tendon of the obturator internus emerges through the small sacro-sciatic foramen. Beneath the quadratus femoris muscle lies the tendon of the obturator externus. To expose the latter necessitates division of the quadratus femoris.

Remove the fascia covering the gluteus medius muscle.

The **gluteus medius muscle** is triangular in shape with its base attached to the ilium and its apex to the great trochanter of the femur. Its anterior portion is covered by the fascia lata, and the smaller posterior portion by the gluteus maximus. It arises from the dorsum of the ilium between the superior curved line and the crest above, the middle curved line below, from the anterior four-fifths of the outer lip of the crest, and from the fascia covering the muscle. The fibers converge to a strong tendon which is inserted into the oblique line on the outer surface of the great trochanter. Between the tendon and the upper part of the trochanter is a small bursa. Superficial to it are the fascia lata, and the gluteus maximus and tensor fasciæ femoris muscles. Its deep relations are the gluteus minimus, the superior gluteal vessels and nerve, and the great trochanter.

NERVE SUPPLY.—Its nerve supply is from the superior gluteal nerve.

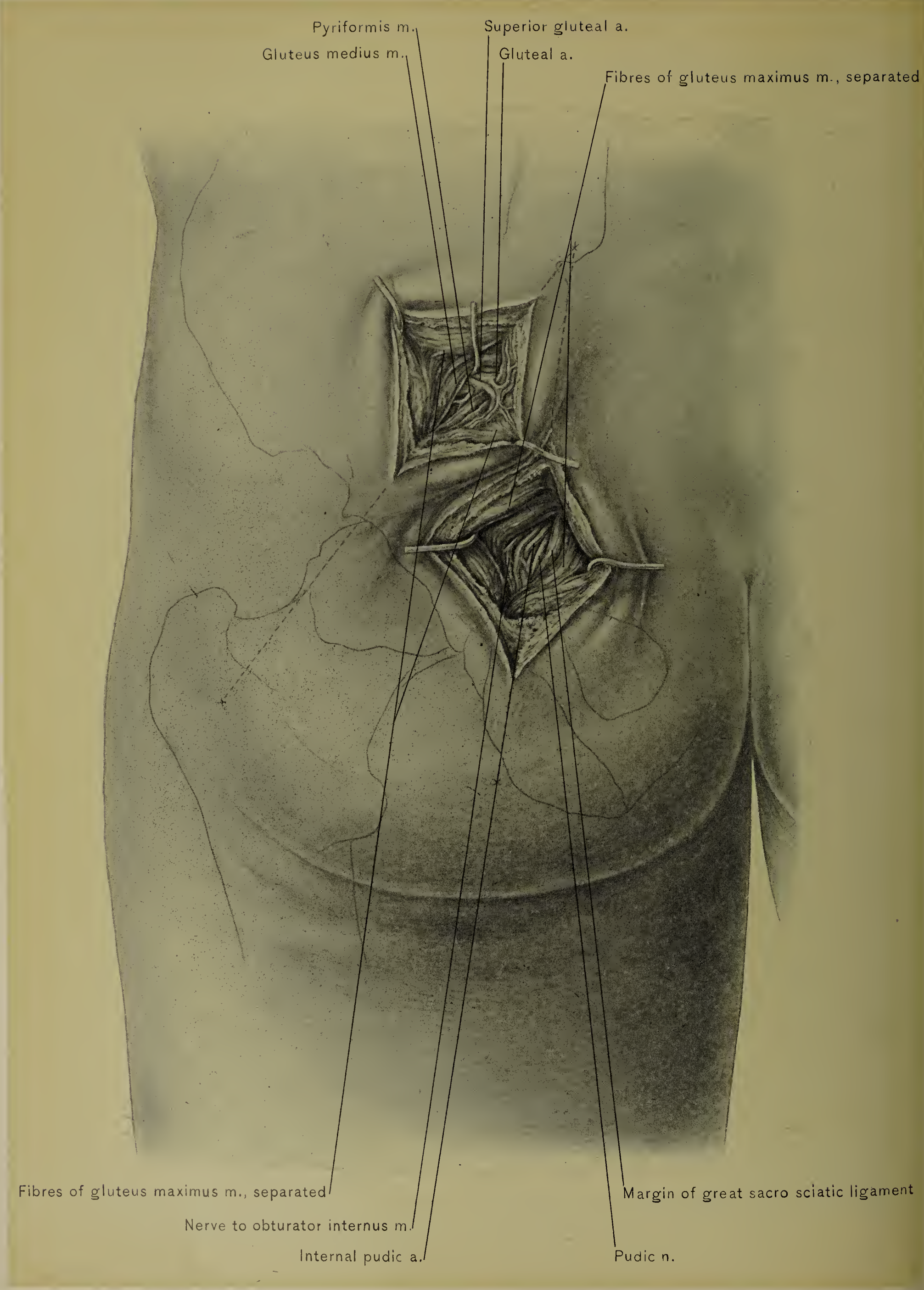
ACTION.—The gluteus medius muscle is an abductor of the thigh and assists in balancing the pelvis on the thigh when standing on one leg; it

is also both an internal and an external rotator, the anterior fibers performing the part of an internal and the posterior fibers that of an external rotator.

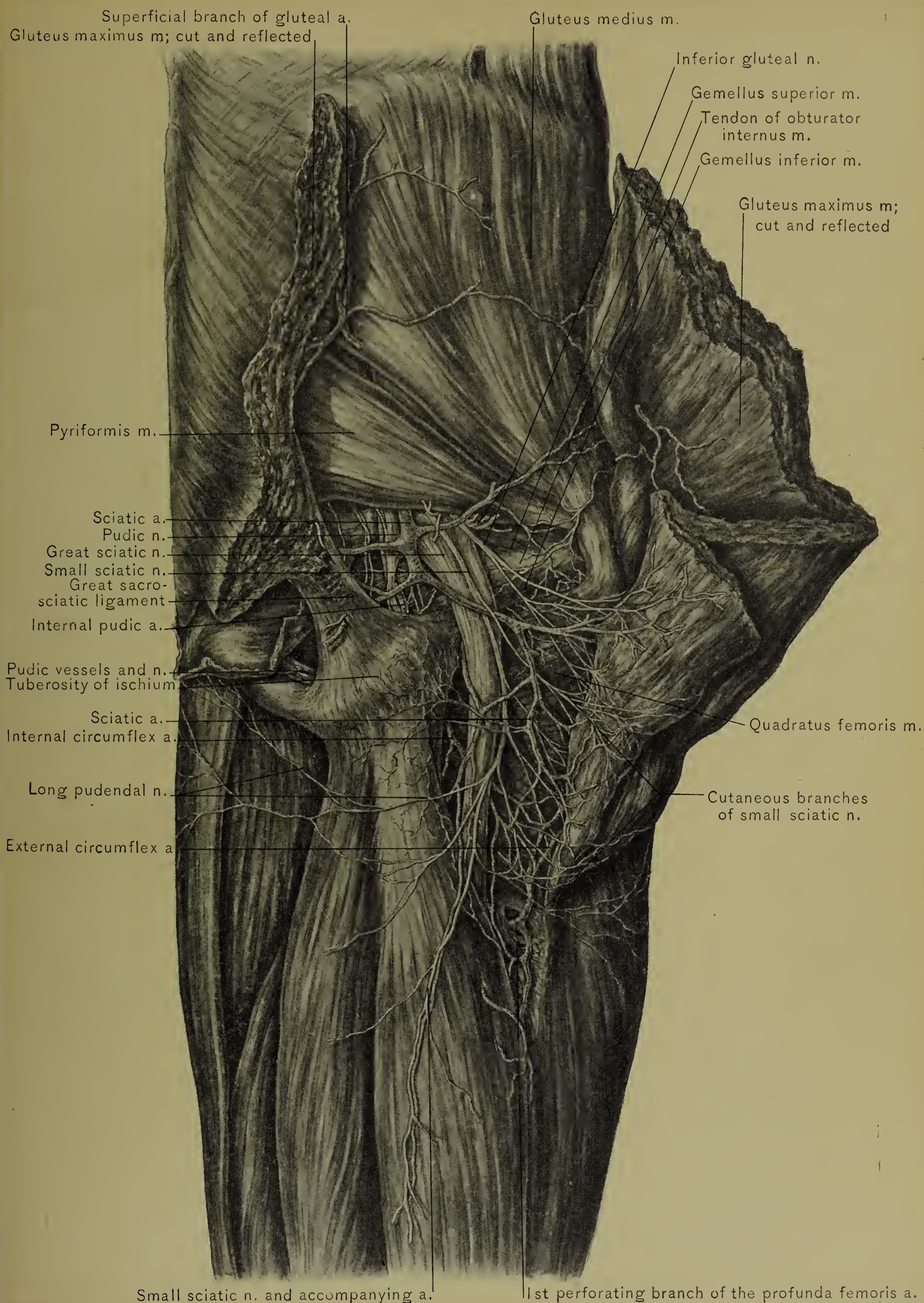
DISSECTION.—The gluteus medius is to be cut across near its origin and reflected downward. This will expose the gluteus minimus muscle, the superior gluteal nerve, and the gluteal artery, a branch of which is a guide in separating the gluteus medius from the gluteus minimus. Trace the branches of the gluteal artery and the superior gluteal nerve which enter its under surface, and divide them. In relation with the anterior border of the gluteus medius muscle is the tensor fasciæ femoris muscle. Along its posterior border is the piriformis muscle.

The **gluteal artery**, the terminal branch of the posterior trunk of the internal iliac, leaves the pelvis through the great sacro-sciatic foramen above the upper border of the piriformis muscle. It passes between the piriformis and the gluteus minimus muscles and divides into two branches, a superficial and a deep. The *superficial branch* passes between the piriformis and gluteus medius to the gluteus maximus which it supplies, together with the overlying integument. It anastomoses with the posterior branches of the lateral sacral arteries, and with the sciatic and the deep circumflex iliac arteries. The *deep branch*, the continuation of the artery, bifurcates between the gluteus medius and minimus muscles into a superior and an inferior branch. The superior branch, accompanied by the superior branch of the superior gluteal nerve, passes along the upper border of the gluteus minimus muscle (being a guide in the separation of the gluteus medius and gluteus minimus) to the anterior part of the ilium, where it anastomoses with the superficial and deep circumflex iliac arteries, and the ascending branches of the external circumflex artery. The inferior branch, accompanied by the inferior branch of the superior gluteal nerve, crosses the gluteus minimus obliquely toward the anterior inferior spine of the ilium and anastomoses with the ascending branch of the external circumflex. The accompanying veins of the gluteal artery have the same relations as the artery, and in the pelvis become the posterior trunk of the external iliac vein. The gluteal artery is about the size of the ulnar artery. Wounds of the buttock will involve only its branches, since a very small portion of the main trunk is seen outside of the pelvis. Hemorrhage from the terminal branches of the gluteal artery may be controlled by compression of the internal iliac through the rectum. Pressure exercised in this manner has proved of little benefit in gluteal aneurysm. Pressure of an aneurysm of the gluteal artery within the pelvis, because of the relation of the artery to the sacral plexus, produces symptoms of nerve irritation.

LIGATION OF THE GLUTEAL ARTERY.—The gluteal artery can be ligated in



LIGATION OF GLUTEAL ARTERY AT ITS POINT OF EXIT AND EXPOSURE OF SCIATIC NERVE.



GLUTEAL REGION WITH GLUTEUS MAXIMUS REFLECTED.

the buttock, through an incision carried in a line drawn from the posterior superior spine of the ilium to the great trochanter, with the thigh rotated inward. The junction of the inner with the middle third of this line marks the point of exit of the artery through the great sacro-sciatic foramen, and should correspond to the center of the incision.

The **superior gluteal nerve** arises from the lumbo-sacral cord and the first sacral nerve. It accompanies the gluteal artery, passing out of the pelvis through the great sacro-sciatic foramen above the piriformis muscle. Immediately after the nerve reaches the gluteal region it divides into two branches. The superior branch accompanies the superior branch of the deep division of the gluteal artery, and supplies the gluteus medius and minimus muscles. The inferior branch accompanies the inferior branch of the deep division of the gluteal artery, crosses the gluteus minimus muscle obliquely, and distributes branches to the gluteus medius and minimus and tensor fasciæ femoris muscles.

The **gluteus minimus**, the smallest of the three gluteus muscles, is triangular in shape and is slightly overlapped, posteriorly, by the piriformis. It arises from the dorsum of the ilium between the middle and inferior curved lines as far back as the margin of the great sacro-sciatic notch. Its fibers converge to a flattened tendon which covers the lower part of the muscle and is inserted into a depression upon the anterior part of the great trochanter. The muscle passes over the capsule of the hip-joint, to which the tendon at its insertion is closely connected. Between the tendon and the great trochanter is a synovial bursa. Superficial to it are the gluteus medius muscle and the superior gluteal vessels and nerve. Its deep relations are the capsule of the hip-joint and the posterior head of the rectus femoris muscle.

NERVE SUPPLY.—The nerve supply of the gluteus minimus muscle is derived from the superior gluteal nerve.

ACTION.—The gluteus minimus is an abductor and an internal rotator of the thigh. Taking its fixed point from the femur, it acts upon the pelvis, supporting it and the whole trunk upon the head of the femur, as in standing upon one leg, and also throws the opposite side of the pelvis forward in walking.

DISSECTION.—Cut through the gluteus minimus muscle near its origin and reflect it; this will expose the long head (reflected tendon) of the rectus femoris muscle, which occupies the groove above the margin of the acetabulum, the capsular ligament of the hip-joint, and the bursa between the tendon and the great trochanter.

The **piriformis muscle** lies immediately below the lower border of the gluteus medius and almost parallel with it. It arises within the pelvis from the front of the second, third, and fourth segments of the sacrum, between the

foramina; from the innominate bone at the upper margin of the great sacro-sciatic notch; and from the deep surface of the great sacro-sciatic ligament. It passes out of the pelvis through the great sacro-sciatic foramen, and terminates in a rounded tendon which is inserted into the upper border of the great trochanter, between the gluteus medius and minimus muscles. It divides the great sacro-sciatic foramen into two parts; the upper gives passage to the gluteal vessels and the superior gluteal nerve; and the lower to the great and small sciatic, the inferior gluteal, and the pudic nerves; the nerves to the obturator internus and quadratus femoris muscles; and the internal pudic and sciatic vessels. In front of it, within the pelvis, are the sacral plexus, internal iliac vessels and some of their branches, and the rectum, especially on the left side. Outside of the pelvis it rests upon the capsule of the hip-joint and the innominate bone. Behind it in the pelvis is the sacrum. Outside of the pelvis it is covered by the gluteus maximus. Its upper border is in relation with the gluteus medius muscle, the gluteal vessels, and the superior gluteal nerve; its lower border, with the inferior gluteal nerve, the coccygeus muscle, the sciatic and internal pudic vessels, the great and small sciatic nerves, and the nerves to the obturator internus and quadratus femoris muscles. When the great sciatic nerve divides within the pelvis, the muscle is sometimes pierced by the external popliteal or peroneal nerve.

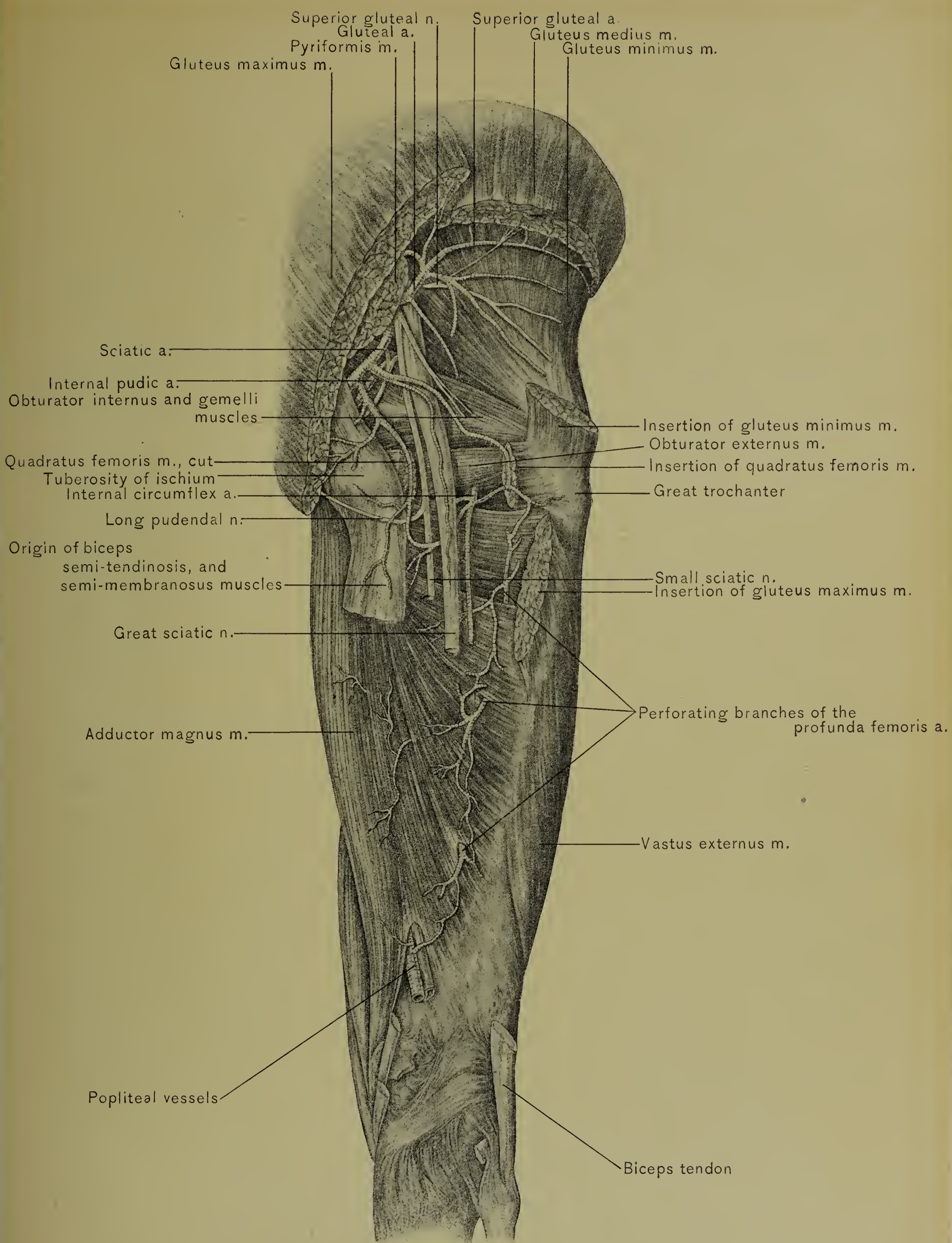
NERVE SUPPLY.—The piriformis receives its nerve supply from the sacral plexus.

ACTION.—The piriformis is an external rotator and abductor of the thigh.

DISSECTION.—The piriformis should be cut across and reflected toward the sacrum, when the sciatic nerves and vessels and the pudic nerve and vessels can be seen leaving the pelvis; their course and relations should be carefully studied before completing the dissection of the muscles of this region.

The **great sciatic nerve** is the largest in the body. It is the continuation of the sacral plexus formed by the anterior branches of the fourth and fifth lumbar nerves and the first three sacral nerves. It passes out of the pelvis through the great sacro-sciatic foramen below the piriformis muscle. It occasionally divides at its origin into its two terminal branches; when this is the case, the external popliteal (peroneal) nerve usually pierces the piriformis muscle. It descends through the interval between the tuberosity of the ischium and the great trochanter, lying a little nearer the former, and thence along the back of the thigh.

Just below the middle of the thigh it usually divides into its two terminal branches, the internal and external popliteal nerves. It rests upon the superior gemellus, the obturator internus, the inferior gemellus, the quadratus femoris,



GLUTEUS MINIMUS SUPERIOR GLUTEAL ARTERY AND NERVES AND OBTURATOR EXTERNUS.

and the adductor magnus muscles. In the thigh, as will be seen in its dissection, the nerve lies upon the adductor magnus to the outer side of the semimembranosus and is covered by the long head of the biceps. It is accompanied for a variable distance by a branch of the small sciatic artery, the *comes nervi ischiadici*, which finally enters its substance.

The branches of the great sciatic nerve are the articular and muscular.

The *articular branches* are distributed to the hip-joint and perforate the capsule posteriorly. The *muscular branches* supply the adductor magnus, the semimembranosus, the semitendinosus, and the biceps muscles.

Sciatica.—The form of neuralgia known as sciatica involves this nerve, and may be due to cold (the nerve being near enough the surface to be influenced by varying degrees of temperature); to spinal disease; or to pressure within the pelvis, as occasioned by a pelvic growth; by an inflammatory deposit; by an aneurysm of one of the branches of the internal iliac; by a sciatic hernia; by the descent of the fetal head; by an impaction of feces; and, in fact, by any form of pressure. Cases of obstinate sciatica, not yielding to the ordinary remedies, may call for operative interference in the shape of *stretching the nerve*. The incision for exposing the nerve is made in a line drawn downward from a point just internal to the midpoint between the tuberosity of the ischium and the great trochanter, to the center of the popliteal space. It may be stretched either at the fold of the buttock or in the middle of the thigh.

The **small sciatic nerve** arises from the anterior branches of the second and third sacral nerves. It leaves the pelvis through the great sacro-sciatic foramen below the piriformis muscle. In this locality the inferior gluteal nerve is generally adherent to it. It runs along the inner side of the great sciatic nerve, accompanied by the sciatic artery. It descends beneath the gluteus maximus, at the lower border of which it comes in immediate relation with the deep fascia, and continues down the back of the thigh, beneath this fascia, to the upper part of the calf, where it becomes subcutaneous. In the calf it accompanies the short saphenous vein to the middle of the leg, where its terminal filaments communicate with the short saphenous nerve. In the upper part of its course it is frequently accompanied by branches of the sciatic artery (cutaneous branches), which anastomose with branches of the perforating arteries of the profunda femoris. Occasionally they accompany the nerve to the knee.

The branches of the small sciatic are the cutaneous and the muscular.

The *muscular branches* enter the under surface of the gluteus maximus near its lower border. These are really the fibers of the inferior gluteal adherent to the small sciatic. The *cutaneous branches* are divided into ascending and internal. The ascending branches turn upward around the lower border of the gluteus

maximus and are distributed to the skin and fascia covering its lower third; the internal branches are distributed to the skin and fascia of the upper and inner side of the thigh posteriorly.

The **inferior pudendal nerve**, or *nerve of Soemmering*, the largest of the internal cutaneous branches of the small sciatic nerve, passes inward below the tuberosity of the ischium, pierces the deep fascia, and is distributed to the perineum and scrotum in the male, and to the labium in the female. It has been described with the perineum.

Pain in the scrotum or labium may be due to pressure upon the trunk of the inferior pudendal nerve or upon the small sciatic, or upon that portion of the sacral plexus or spinal cord from which the filaments arise; while, on the other hand, pressure upon the terminal part of the inferior pudendal may give rise to pain referred to the back of the thigh.

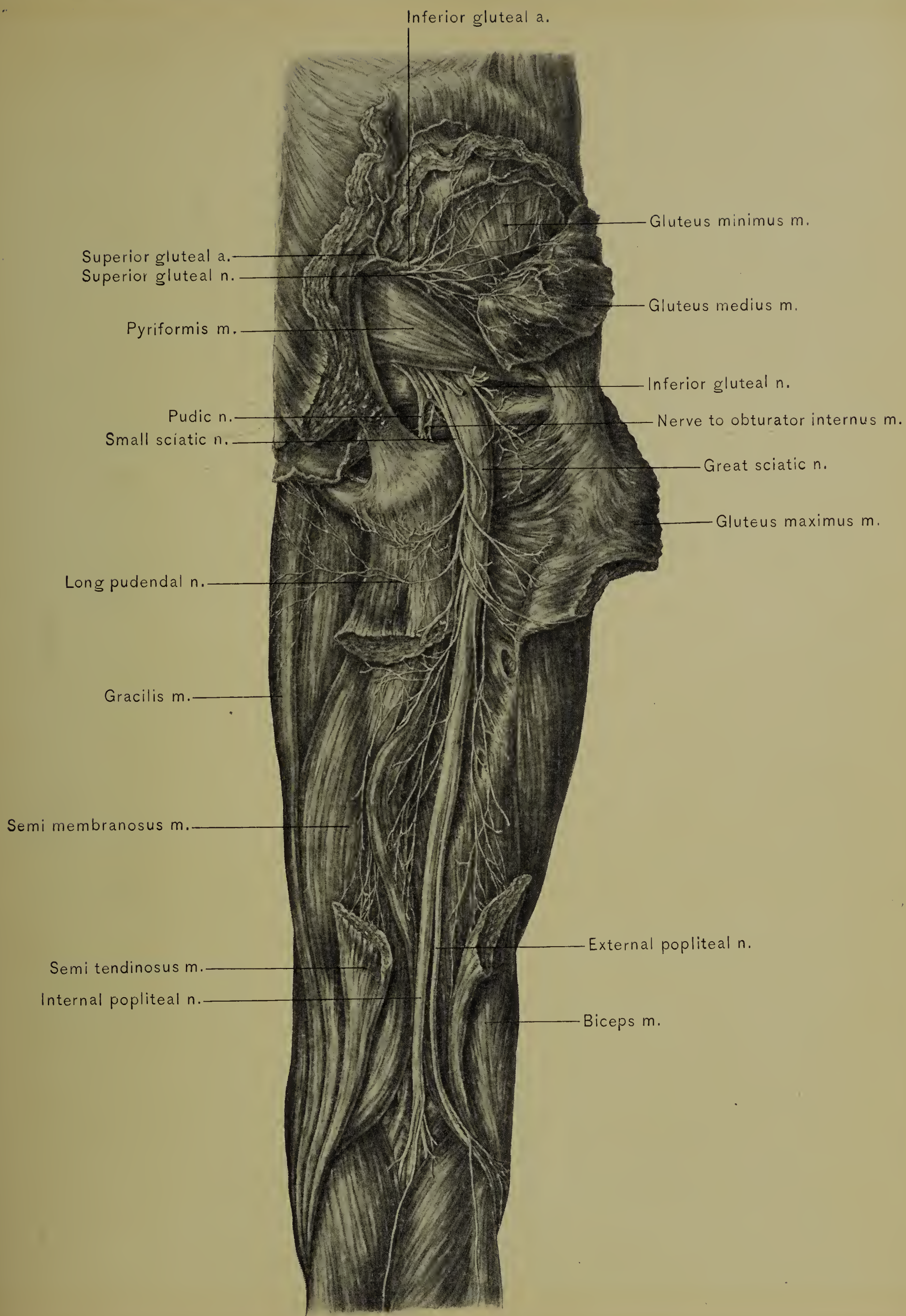
The **inferior gluteal nerve** arises from the second and third sacral nerves. It passes out of the pelvis through the great sacro-sciatic foramen below the pyriformis muscle, and enters the under surface of the gluteus maximus muscle, which it supplies. In the foramen it is often adherent to the small sciatic nerve.

By displacing the great sciatic nerve outward the nerve to the obturator internus and the nerve to the quadratus femoris can be seen.

The **nerve to the obturator internus muscle** arises from the second and third sacral nerves. It passes out of the pelvis through the great sacro-sciatic foramen below the pyriformis and crosses the base of the spine of the ischium on the outer side of the pudic vessels and nerve. It gives off a branch to the superior gemellus and enters the lesser sacro-sciatic foramen to supply the obturator internus.

The **nerve to the quadratus femoris muscle** arises from the third sacral nerve. It is often adherent to the under surface of the great sciatic nerve. It passes under the tendon of the obturator internus muscle and the gemelli muscles. It supplies the inferior gemellus, the quadratus femoris, and the hip-joint.

The **sciatic artery**, the larger of the two terminal branches of the anterior trunk of the internal iliac, emerges from the pelvis, through the great sacro-sciatic foramen below the pyriformis muscle. It descends in the interval between the tuberosity of the ischium and the great trochanter in company with the great sciatic nerve and passes over the superior gemellus, the tendon of the obturator internus, the inferior gemellus, the quadratus femoris, and the upper part of the adductor magnus. It terminates in the descending branch which accompanies the small sciatic nerve and anastomoses with the superior perforating and with the external and the internal circumflex arteries. Occasionally this artery



GREAT SCIATIC NERVE.

may be double, and may give origin to the femoral artery, which then passes down the back of the thigh to the popliteal space.

The branches given off from the artery outside the pelvis are the coccygeal, inferior gluteal, *comes nervi ischiadici*, muscular, articular, cutaneous, and anastomotic.

The *coccygeal branch* perforates the great sacro-sciatic ligament and supplies the gluteus maximus and the structures on the back of the sacrum and coccyx. It anastomoses with its fellow of the opposite side. The inferior gluteal enters the under surface of the gluteus maximus with the inferior gluteal nerve.

The *comes nervi ischiadici* accompanies the great sciatic nerve and finally enters its substance.

The *muscular branches* supply the muscles behind the hip-joint.

The *articular branches* are distributed to the capsule of the hip-joint.

The *cutaneous branches* accompany the cutaneous branches of the small sciatic nerve and supply the integument of the lower portion of the gluteal region.

The *anastomotic branches* pass outward over the quadratus femoris to the trochanteric fossa, anastomosing with the internal and external circumflex and the superior perforating, thus establishing the *crucial anastomosis*. The sciatic artery also anastomoses with the obturator and the gluteal arteries, and forms an important part of the collateral circulation after ligation of the femoral, the common iliac, or the external iliac arteries.

LIGATION OF THE SCIATIC ARTERY.—The sciatic artery can be ligated in the buttock through an incision carried in a line drawn from the posterior superior spine of the ilium to the outer side of the tuberosity of the ischium. The junction of the upper with the middle third of this line marks the point of exit of the artery through the great sacro-sciatic foramen, and should correspond to the center of the incision.

The **internal pudic artery**, the smaller of the two terminal branches of the anterior trunk of the internal iliac, emerges from the pelvis through the great sacro-sciatic foramen below the pyriformis muscle. It lies internal to the sciatic artery, and as it winds over the spine of the ischium and passes into the pelvis through the lesser sacro-sciatic foramen, the *venæ comites* lie on either side, the pudic nerve lies internal to it, and the nerve to the obturator internus to its outer side. For further description of its course see the description of the perineum. Hemorrhage from the internal pudic artery has been arrested by compressing the vessel against the spine of the ischium. Like the gluteal and sciatic arteries, it can be ligated in the buttock through an incision somewhat similar to that for the ligation of the sciatic, differing from it, however, in that the center of the incision should correspond to the junction

of the middle with the lower third of the line, which point marks the point of entrance of the internal pudic artery into the lesser sacro-sciatic foramen. It gives off a few branches to the gluteus maximus and the obturator internus muscles, and a sacral branch which pierces the great sacro-sciatic ligament and anastomoses with the sciatic artery.

The Sciatic and Internal Pudic Veins.—The sciatic and internal pudic arteries are accompanied by veins receiving branches corresponding to those of the arteries, and, by their union within the pelvis, form the anterior trunk of the internal iliac vein.

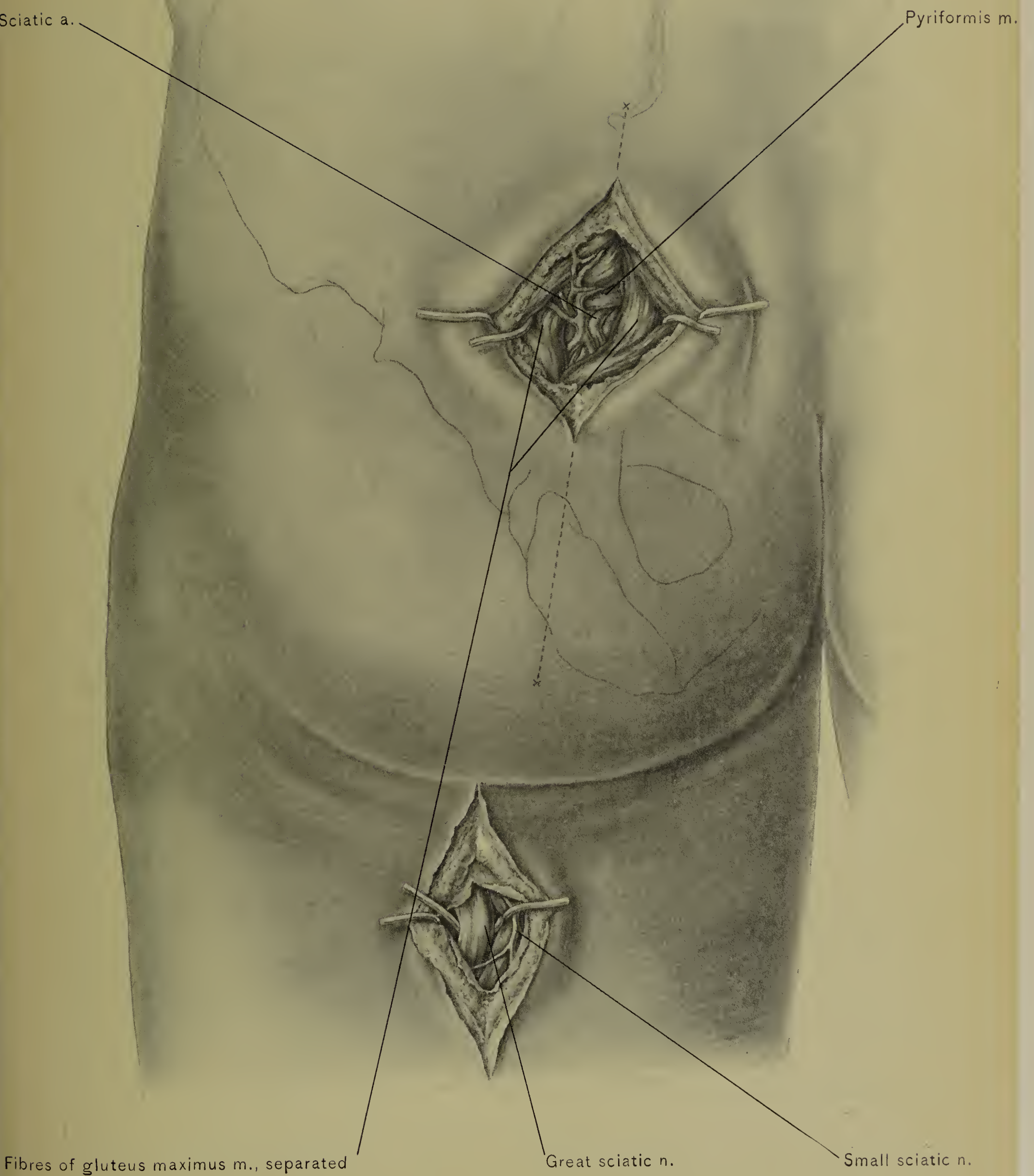
The **pudic nerve**, a branch of the sacral plexus, arises from the second, third, and fourth sacral nerves. It leaves the pelvis through the great sacro-sciatic foramen, below the piriformis muscle. Accompanying the internal pudic artery, but lying to its inner side, it runs over the spine of the ischium near the attachment of the lesser sacro-sciatic ligament, and enters the pelvis through the lesser sacro-sciatic foramen.

DISSECTION.—To study the remaining muscles of the gluteal region, the great sciatic nerve should be displaced laterally, and, if necessary, the branches of the sciatic artery cut away.

The **gemelli muscles**, superior and inferior, are accessory to the obturator internus, and are situated one above, and the other below, the tendon of that muscle. The *superior gemellus muscle*, the smaller of the two, arises from the outer surface of the spine of the ischium and is inserted into the upper border of the tendon of the obturator internus muscle. Occasionally it is absent. The *inferior gemellus muscle* arises from the upper and back part of the tuberosity of the ischium and is inserted with the tendon of the obturator internus muscle into the great trochanter.

NERVE SUPPLY.—The branch to the superior gemellus is derived from the nerve to the obturator internus; that to the inferior gemellus is derived from the nerve to the quadratus femoris.

The **obturator internus muscle** arises within the pelvis from the body and descending ramus of the pubis, the ascending ramus of the ischium, and the bone between the foramen and the great sacro-sciatic notch, the internal surface of the obturator membrane, and from the obturator fascia, which covers the muscle. The fibers are directed backward and outward and terminate in four tendinous bands found on the deep surface of the muscle. It leaves the pelvis through the lesser sacro-sciatic foramen. The four bands unite to form a single tendon which is inserted into the internal surface of the great trochanter at its upper part, in front of the piriformis. The four bands pass over the inner surface of the tuberosity of the ischium, which is covered with cartilage



LIGATION OF SCIATIC ARTERY AT ITS POINT OF EXIT AND OF INTERNAL PUDIC ARTERY.

and a large synovial bursa. Within the pelvis it is in relation externally with the obturator membrane and the innominate bone; internally, with the obturator fascia, the levator ani muscle, the pelvic viscera, and the pudic vessels and nerve; above, with the obturator vessels and nerve. Outside the pelvis the tendon of the obturator internus muscle and the gemelli muscles are in relation, above, with the piriformis muscle and the sciatic nerves and vessels; below, with the quadratus femoris muscle and branches of the internal circumflex artery; in front of them lie the capsule of the hip-joint and the tendon of the obturator externus muscle; and they are covered behind by the gluteus maximus muscle, the sciatic vessels and nerves, and the great sacro-sciatic ligament.

NERVE SUPPLY.—The nerve supplying this muscle is a branch of the second and third sacral nerves and leaves the pelvis through the great sacro-sciatic foramen, passes over the spine of the ischium, and then enters the pelvis through the lesser sciatic foramen to reach the under surface of the muscle.

ACTION.—The action of the obturator internus, with the gemelli, is to rotate the thigh outward; when the hip-joint is flexed, these muscles assist slightly in abduction.

The **quadratus femoris muscle** is situated between the inferior gemellus and the upper border of the adductor magnus. It arises from the upper border of the outer surface of the tuberosity of the ischium and passes horizontally outward to be inserted into the upper part of the linea quadrati, a line running downward from the posterior inter-trochanteric line. Between the lower border of the quadratus femoris and the upper border of the adductor magnus emerges the terminal branch of the internal circumflex artery. Between it and the lesser trochanter is a small synovial bursa. In front are the obturator externus muscle and branches of the internal circumflex artery; above it is the inferior gemellus, and below it, the adductor magnus muscle. Behind it are the gluteus maximus muscle and the sciatic vessel and nerves.

NERVE SUPPLY.—It receives its nerve supply through a branch of the sacral plexus, which passes beneath the gemelli and the tendon of the obturator internus muscle to enter its under surface.

ACTION.—Its action is to assist in the abduction and external rotation of the thigh.

DISSECTION.—The quadratus femoris is to be divided and reflected, when the obturator externus will be brought into view.

The **obturator externus muscle** arises from the descending ramus of the pubes, the ascending ramus of the ischium, the inner two-thirds of the outer

surface of the obturator membrane, and from the tendinous arch over the obturator vessels. The fibers pass backward and outward and terminate in a tendon which runs across the back of the hip-joint and is inserted into the digital (trochanteric) fossa on the inner surface of the great trochanter. In front of it are the psoas, pectineus, and adductor brevis muscles; behind it, the quadratus femoris muscle and the obturator vessels; above it are the obturator vessels and nerve and the capsule of the hip-joint. Behind it are the obturator membrane and the innominate bone.

NERVE SUPPLY.—It receives its nerve supply from the posterior division of the obturator, which enters the under surface of the muscle.

ACTION.—It is an external rotator of the thigh.

THE POPLITEAL SPACE.

DISSECTION.—This part of the body should be dissected before the back of the thigh, as otherwise the boundaries would be more or less disturbed. The limb is to remain in the same position as for the dissection of the buttock. Carry a vertical incision through the center of the space and at each extremity make a transverse incision. The skin is then dissected up in two flaps, care being taken not to remove the cutaneous branches of the small sciatic nerve.

The **Popliteal Space** is the hollow behind the knee, and is seen to the best advantage when the leg is but slightly flexed upon the thigh. With the leg in the extended position, the hollow is replaced by the rounded prominence of the condyloid extremity of the femur carrying in advance of it the overlying soft parts.

The skin of this region is thinner and not as movable as that covering the front of the knee. If destroyed by injury, by burns, or by extensive ulceration, the resulting cicatrix may contract to such an extent as to cause marked and permanent flexion of the knee; this is to be guarded against by keeping the leg extended during the process of healing and by subsequently wearing for some time an apparatus which will maintain the limb in the straight position. The skin here has been ruptured by forcible extension applied to the knee in cases of contraction.

In the superficial fascia are seen cutaneous branches of the small sciatic and internal cutaneous nerves, the terminal part of the small saphenous vein, and a number of superficial lymphatic glands. The last-mentioned are liable to undergo enlargement and suppuration after injuries to the foot and leg.

DISSECTION.—Reflect the superficial fascia by making incisions similar to those made in reflecting the skin. This will bring into view the popliteal fascia.

The **popliteal fascia** is continuous with the fascia lata and the deep fascia of the leg. It forms the roof of the popliteal space; it is attached to the bony prominences of the knee, and connected laterally with the sheaths of the tendons bounding the space. Strong transverse bands connecting the tendons are stretched across the space and render the fascia very tense. From its strength and power of resistance it complicates the diagnosis of tumors in this space and limits the progress of popliteal abscess toward the surface. The very severe pain associated with tumors and collections of pus in this space is caused by the unyielding character of the fascia. A popliteal abscess unable to reach the surface may extend either upward into the thigh or downward into the leg. This space may hold a very considerable quantity of pus. "Velpeau has seen a case where a pint of pus was evacuated from this region in a patient who presented, before the operation, only a slight swelling at the site of the collection. Duplay records two cases of ulceration of an abscess into the popliteal artery, and Ollivier, an instance where the abscess, unable to find a way to escape, ultimately entered the knee-joint" (Treves). Pus can reach the space from the buttock or from the pelvis, by following the great sciatic nerve; or may extend from the thigh through the opening in the adductor magnus muscle for the femoral vessels. This fascia is pierced by the short saphenous vein and the small sciatic nerve.

DISSECTION.—The fascia is now to be reflected, care being taken not to injure the short saphenous vein and the small sciatic nerve. This opens up the popliteal space.

The **popliteal space** is diamond-shaped, widest immediately behind the knee, and deepest above the articular end of the femur. It is bounded, externally and above, by the tendon of the biceps muscles; internally and above, by the tendons of the semitendinosus and semimembranosus, gracilis, and sartorius muscles; externally and below, by the external head of the gastrocnemius muscle and the plantaris muscle; internally and below, by the inner head of the gastrocnemius muscle. Its floor, from above downward, is formed by the posterior surface of the lower third of the shaft of the femur included between the two condyloid ridges, by the posterior ligament of the knee-joint, and by the popliteus muscle. Its roof, already described, is formed by the popliteal fascia. It contains the popliteal artery and its branches, the popliteal vein and its tributaries, the articular branch of the obturator nerve to the knee-joint, the internal and external popliteal nerves and their branches, the small sciatic nerve, the terminal part of the short saphenous vein on its way to enter the popliteal, lymphatic glands, and a quantity of adipose and cellular tissue continuous with that surrounding the muscles of the back of the thigh and calf. The fact that the connective and adipose tissues of this space are continuous with that surrounding the

adjacent muscles explains why collections of pus in the space are liable to extend into the thigh or the leg.

DISSECTION.—The contents of the space and their relations are now to be carefully examined, the fat being removed as the dissection is carried on.

The **internal popliteal nerve**, the larger of the two terminal divisions of the great sciatic, runs through the middle of the popliteal space. It lies superficial to the popliteal vein and artery, crosses these vessels from without inward, and terminates at the lower border of the popliteus muscle in the posterior tibial nerve. The relations of the internal popliteal nerve, the popliteal vein, and the popliteal artery, vary in the upper, middle, and lower portions of the space. The relation throughout the space from the surface inward, or in the order of the dissection, is the same in all portions, and is nerve, vein, and artery; in the extreme upper portion of the space both the nerve and vein lie external to the artery; in the middle portion the nerve and vein lie directly over the artery; in the extreme lower portion the nerve and vein lie to the inner side of the artery, the nerve being more internal.

The branches of the internal popliteal nerve are the articular, muscular, and cutaneous.

The *articular branches*, three in number, pierce the back of the capsule of the knee-joint. They accompany the superior, internal, and external articular arteries and the azygos artery.

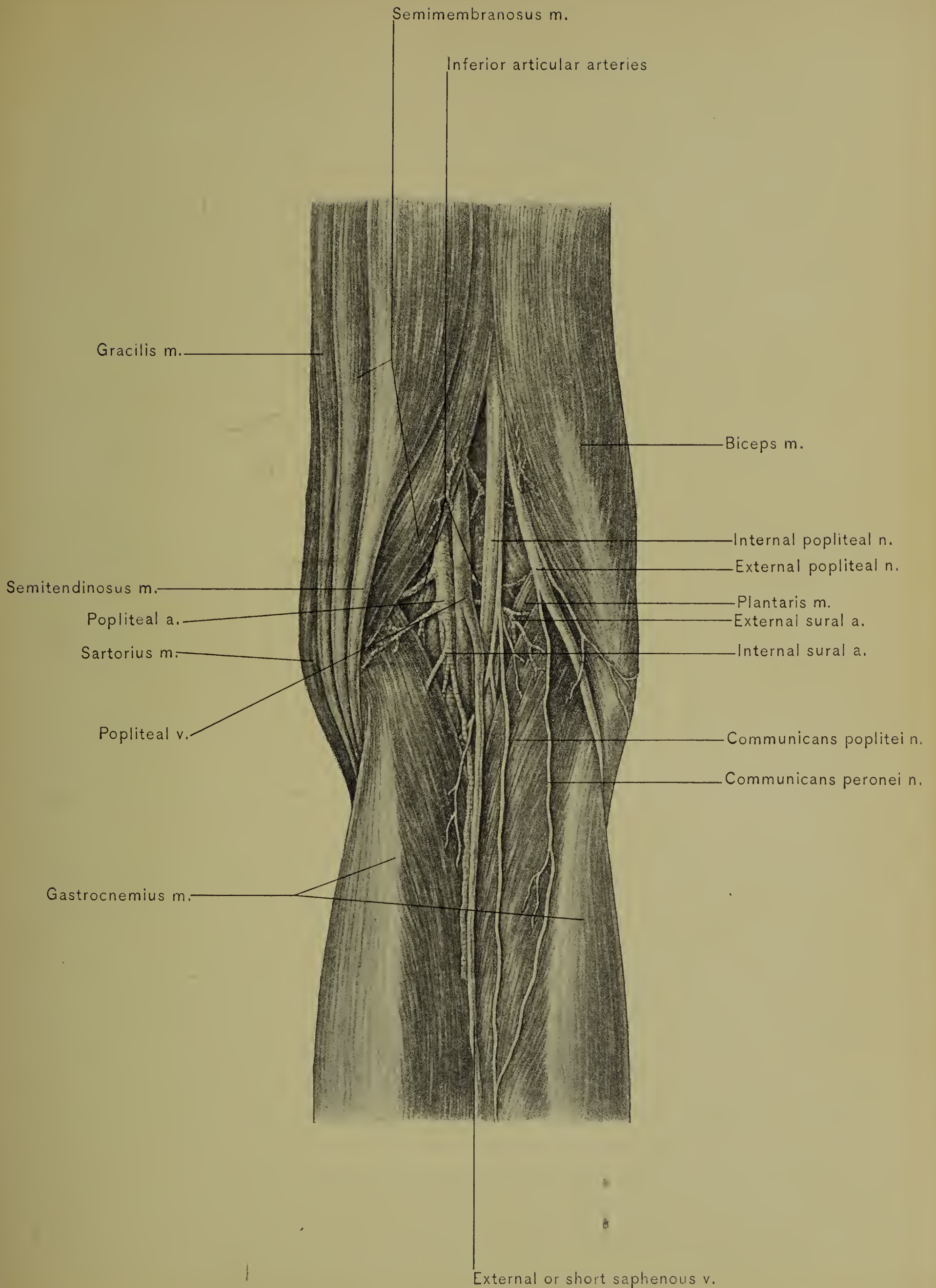
The *muscular branches*, four or five in number, supply the two heads of the gastrocnemius, the plantaris, the soleus, and the popliteus muscles.

The *cutaneous branch*, also called the *communicans poplitei nerve*, descends in the groove between the two heads of the gastrocnemius muscle, and pierces the deep fascia of the leg about the middle of the calf, where it is joined by a branch (*communicans peronei*) of the external popliteal nerve, to form the short saphenous nerve.

The **external popliteal or peroneal nerve**, the remaining terminal division of the great sciatic, passes along the outer border of the popliteal space close to the inner side of the tendon of the biceps. It leaves the space by passing below the bicipital tendon and winds around the fibula about one inch (2.5 centimeters) below its head, where it pierces the peroneus longus muscle and divides into its two terminal branches, the anterior tibial and the musculo-cutaneous nerves.

The branches of the external popliteal nerve are articular and cutaneous.

The *articular branches*, two in number, accompany the superior and inferior external articular arteries to the outer side of the knee; a recurrent articular branch, which runs with the recurrent artery through the tibialis anticus muscle to the front of the knee, is given off from the external popliteal nerve, where it divides.



The *cutaneous branches*, two or three in number, supply the skin and fascia along the posterior and outer aspect of the leg as far as the middle third. The *communicans peronei*, the largest cutaneous branch, arises near the head of the fibula, crosses the outer head of the gastrocnemius muscle, and reaching the middle of the leg, joins the *communicans poplitei* nerve to form the short saphenous nerve. In some cases the *communicans peronei* continues as a separate branch as far as the heel.

DISSECTION.—The fat occupying the deep part of the space, with the four or five lymphatic glands contained therein, is to be removed, when the popliteal vessels and their branches will be seen.

Popliteal lymph glands: It is important to note that one of the lymphatic glands generally lies on the popliteal artery, and, if enlarged, would give rise to a pulsating tumor which might be mistaken for an aneurysm.

The **popliteal artery**, the continuation of the superficial femoral, commences at the opening in the adductor magnus muscle and passes through the middle of the popliteal space to the lower border of the popliteus muscle, where it ends by dividing into its two terminal branches—the anterior and posterior tibial arteries. It rests, from above downward, on the posterior surface of the lower third of the femur, upon the posterior ligament of the knee-joint, and upon the fascia covering the popliteus muscle. In the upper part of the space the popliteal artery is concealed by the outer margin of the semimembranosus muscle, and in the lower part of the space by the inner head of the gastrocnemius muscle, and the plantaris and the soleus muscles. Occasionally the popliteal artery divides into its terminal branches opposite the knee-joint. The artery sometimes divides into the anterior tibial and the peroneal arteries, the posterior tibial artery being either wanting or very small. In a single instance the popliteal artery has been found to divide into three branches—the anterior and posterior tibial and the peroneal.

The branches of the popliteal artery are the articular, which are given off from the vessel at right angles, the muscular, and the cutaneous.

The *articular branches* are the superior external and internal, the inferior external and internal, and the azygos articular.

The *superior articular arteries* arise from the popliteal, one on each side above the condyles of the femur, pass almost transversely beneath the hamstring muscles, and wind round the femur to reach the front of the knee-joint. The *superior external articular artery* passes beneath the tendons of the biceps, pierces the external intermuscular septum, and divides into two branches—a superficial and a deep; the superficial branch anastomoses with the descending branch of the external circumflex artery and supplies the vastus externus muscle; the deep

branch forms an arch across the femur with the *anastomotica magna* artery and supplies the lower part of the femur and the knee-joint. The *superior internal articular artery* passes beneath the tendon of the adductor magnus and divides into two branches, one of which supplies the vastus internus and anastomoses with the *anastomotica magna* and inferior internal articular arteries; the other branch anastomoses with the superior external articular artery and supplies the knee-joint.

The *inferior articular arteries* arise beneath the heads of the gastrocnemius muscle and wind round the head of the tibia to reach the front of the knee-joint. The *inferior external articular artery* passes beneath the tendon of the biceps, above the head of the fibula, to the front of the knee and anastomoses with the inferior internal articular, the superior external articular, and the recurrent tibial arteries. The *inferior internal articular artery* passes beneath the internal lateral ligament, below the inner tuberosity of the tibia, and ascends to the front and inner side of the knee-joint, anastomosing with the superior internal articular and the inferior external articular arteries.

The *azygos articular artery* pierces the posterior ligament of the knee-joint and supplies the ligamentous structures, the fat, and the synovial membrane in the interior of the joint.

The *muscular branches* consist of an upper and a lower set. The upper set supplies the vastus externus, the semimembranosus, and the biceps muscle, and anastomoses with the lower perforating branches of the profunda femoris artery. The lower set (sural), two large branches, are distributed to the heads of the gastrocnemius, the plantaris, and the soleus muscles.

The *cutaneous branches*, usually three in number, arise from the popliteal or its branches and supply the skin of the back of the leg as far as the middle.

The **popliteal vein** is intimately associated with the artery and, in the upper portion of the space, lies superficial and external to it; in the middle portion it lies superficial to and over it, and, in the lower portion, superficial and internal to it. It commences at the lower border of the popliteus muscle by the union of the companion veins of the anterior and posterior tibial arteries and ends at the opening in the adductor magnus muscle, beyond which it is continued as the superficial femoral vein. Into it empty the short saphenous vein and the *venæ comites* of the branches of the popliteal artery.

Between the popliteal artery and the popliteal vein is the **articular branch of the obturator nerve** which pierces the posterior ligament of the knee-joint to be distributed to the synovial membrane; it enters the popliteal space by piercing the adductor magnus muscle.

The Surgery of the Popliteal Vessels.—The popliteal artery may be injured, in the living subject, when the inner and middle coats are diseased, by violent

flexion and extension of the leg. The inner coat is the one most likely to be ruptured, and is soon followed by dilatation of the remaining coats, and aneurysm results. By strongly flexing and extending the knee in the cadaver, the inner and middle coats of the artery can be ruptured.

Aneurysm of the popliteal artery is of common occurrence, this vessel being more often the seat of aneurysm than any other in the body, except the thoracic aorta. The reason of this is that, owing to the position the artery holds with relation to the knee-joint, it is being constantly subjected to movement which is often of a violent character. Popliteal aneurysm may burst into the knee-joint, extravasate into the popliteal space, and burrow up the thigh or down the leg.

From the relation the artery holds to the vein and internal popliteal nerve, it is understood why, in an aneurysm of any size, swelling of the leg and foot coexist, and why numbness or pain is complained of.

From the relation the popliteal artery bears to the lower third of the femur, it must not be lost sight of that the vessel may be injured in fracture of this portion of the bone. Having reduced such a fracture, it is good practice to maintain the limb with the knee in the slightly flexed position for a few days at least, fearing the consequence of strong extension applied immediately to the leg. Should the limb, however, be placed in the extended position from the start, the force of the circulation, as shown by the pulse, in the dorsalis pedis and posterior tibial arteries, compared with that of the sound side, should be carefully noted from time to time.

The popliteal vessels, being very deep, are seldom wounded. The lower part of the artery may be reached from the anterior aspect of the leg by an instrument passing between the tibia and the fibula. Spence reports the case of a farmer who received a wound in the front of the leg just below the knee from the slipping of his knife while cutting a stick. The knife entered the interosseous space and wounded the popliteal artery at its bifurcation, nearly severing the anterior tibial artery from the main trunk.

The position of the limb most favorable for the examination of the popliteal space, as has already been noted, is with the knee-joint partly flexed. The popliteal artery is much curved except when the leg is extended; unlike many of the other large vessels, it is not supported by strong muscles, but surrounded simply by fat and areolar tissue. By strongly flexing the knee, the lumen of the popliteal artery is directly affected and the pulsation in the anterior and posterior tibial arteries, as felt in front of the ankle and behind the internal malleolus, is materially weakened.

Ligation of the popliteal artery, except for a wound of the vessel, is never performed. In popliteal aneurysm the superficial femoral artery is tied at its

point of election. The popliteal artery can be exposed in the upper portion of the popliteal space by one or two incisions—namely, through the roof and through the inner side of the space. In reaching the artery by the latter method the incision is carried along the tendon of the adductor magnus muscle or the posterior border of the lower third of the femur, dividing the skin, the superficial fascia, and the deep fascia, when the sartorius muscle will be exposed. This is to be displaced downward, thus opening up the interval bounded in front by the femur, the tendon of the adductor magnus, and the vastus internus muscle, and behind by the displaced sartorius, the gracilis, and the semimembranosus muscles. Through this interval the finger can be carried into the popliteal space and the pulsation of the vessel felt. In dividing the superficial fascia the long saphenous vein is to be avoided, and, after the sartorius has been displaced, the long saphenous nerve may be seen passing beneath it.

The popliteal vein is a remarkably strong vessel with dense thick walls, as is seen by its showing little tendency to collapse when divided in an amputation of the knee-joint; in this respect it resembles an artery. This is further demonstrated by recalling that it is very rarely ruptured by violence, notwithstanding that it lies more superficial than the artery; as a rule, the artery alone is torn. The popliteal vein and artery are very adherent to each other, as is readily observed when separating them prior to passing the ligature, when ligating the artery.

A *popliteal abscess* may be evacuated by making an incision through either the roof of the space or above the tendon of the biceps, between it and the ilio-tibial band. In either case, if the collection is not at once reached, further exploration should be made with the finger or a grooved director.

The *bursæ* in relation with the lateral boundaries of the popliteal space usually number six, and are situated two on the inner and four on the outer side. Of the two on the inner side of the space, one is between the internal condyle of the femur and the inner head of the gastrocnemius and the semimembranosus, and one between the inner tuberosity of the tibia and the tendon of the semimembranosus. The bursa between the internal condyle of the femur and the inner head of the gastrocnemius and semimembranosus is the largest of all in relation with the popliteal space, and the one most often enlarged. In the majority of cases it communicates with the knee-joint in adult life. By extending the leg under such conditions the bursa is rendered tense, while, if the leg be flexed, it becomes relaxed and may entirely disappear by emptying its contents into the joint. The small bursa between the inner tuberosity of the tibia and the tendon of the semimembranosus seldom, if ever, communicates with the knee-joint, although it may communicate with the large bursa over the internal condyle. Of the four *bursæ* on the outer side of the popliteal space, one is

between the tendon of the popliteus muscle and the external lateral ligament of the knee, one between the tendon of the popliteus and the outer tuberosity of the tibia (and is an extension of the synovial membrane of the knee), one between the outer head of the gastrocnemius muscle and the external condyle of the femur, and one between the tendon of the biceps and the external lateral ligament of the knee, over which runs the external popliteal nerve. It is readily understood how wounds of any of these bursæ may be mistaken for wounds of the knee-joint, the escaping bursal fluid being thought to be synovial. Enlargement of the bursa over which runs the external popliteal nerve may excite sufficient pressure to cause pain to be referred to the line of distribution of its branches, if not paralysis of the muscles supplied by it. In the diagnosis of surgical affections of the popliteal space, as well as the knee-joint, the presence of these bursæ must not be lost sight of, as both acute and chronic inflammation of one or more of them will figure among the conditions to be thought of in arriving at a satisfactory solution of the case.

In certain cases of contracted knee, division of the *hamstring tendons*, either alone or in connection with the popliteal fascia, is called for. When division of the tendons will suffice, it is best done subcutaneously. In dividing the tendon of the biceps subcutaneously, care is required not to cut the external popliteal nerve; this nerve is in greater danger of being wounded, however, when resecting the head of the fibula. With the leg extended, the tendon is brought nearer the surface and the distance between it and the nerve increased. If it becomes necessary to divide both the popliteal fascia and the tendons, the safer operation would be the open one.

THE BACK OF THE THIGH.

DISSECTION.—The dissection of the popliteal space having been completed, that of the back of the thigh, extending from the gluteal fold to the popliteal space, should next be made. Carry a longitudinal incision through the integument intervening between the gluteal region and the popliteal space, connecting the one made in the dissection of the former with that made in the dissection of the latter, and reflect it to either side.

The superficial fascia is rich in fat and contains, upon the outer aspect of the limb, cutaneous branches of the posterior division of the external cutaneous nerve; in the middle line of the limb, cutaneous branches of the small sciatic nerve; and, on the inner aspect of the thigh, branches of the internal cutaneous and obturator nerves.

The veins occupying the superficial fascia are very small.

DISSECTION.—Reflect the superficial fascia by an incision similar to that made in the skin and expose the deep fascia.

The fibers of the deep fascia run chiefly in a transverse direction ; the fascia becomes stronger near the popliteal space, where it forms the popliteal fascia.

The deep fascia is to be removed after the manner of the superficial, taking care not to destroy the small sciatic nerve and the terminal branch of the sciatic artery. These will now be exposed, together with the flexor muscles of the thigh, the great sciatic nerve and its terminal divisions, and the perforating branches of the deep femoral artery ; all of these structures are to be carefully cleaned and their relations noted.

The *small sciatic nerve* and *sciatic artery* have been described with the gluteal region.

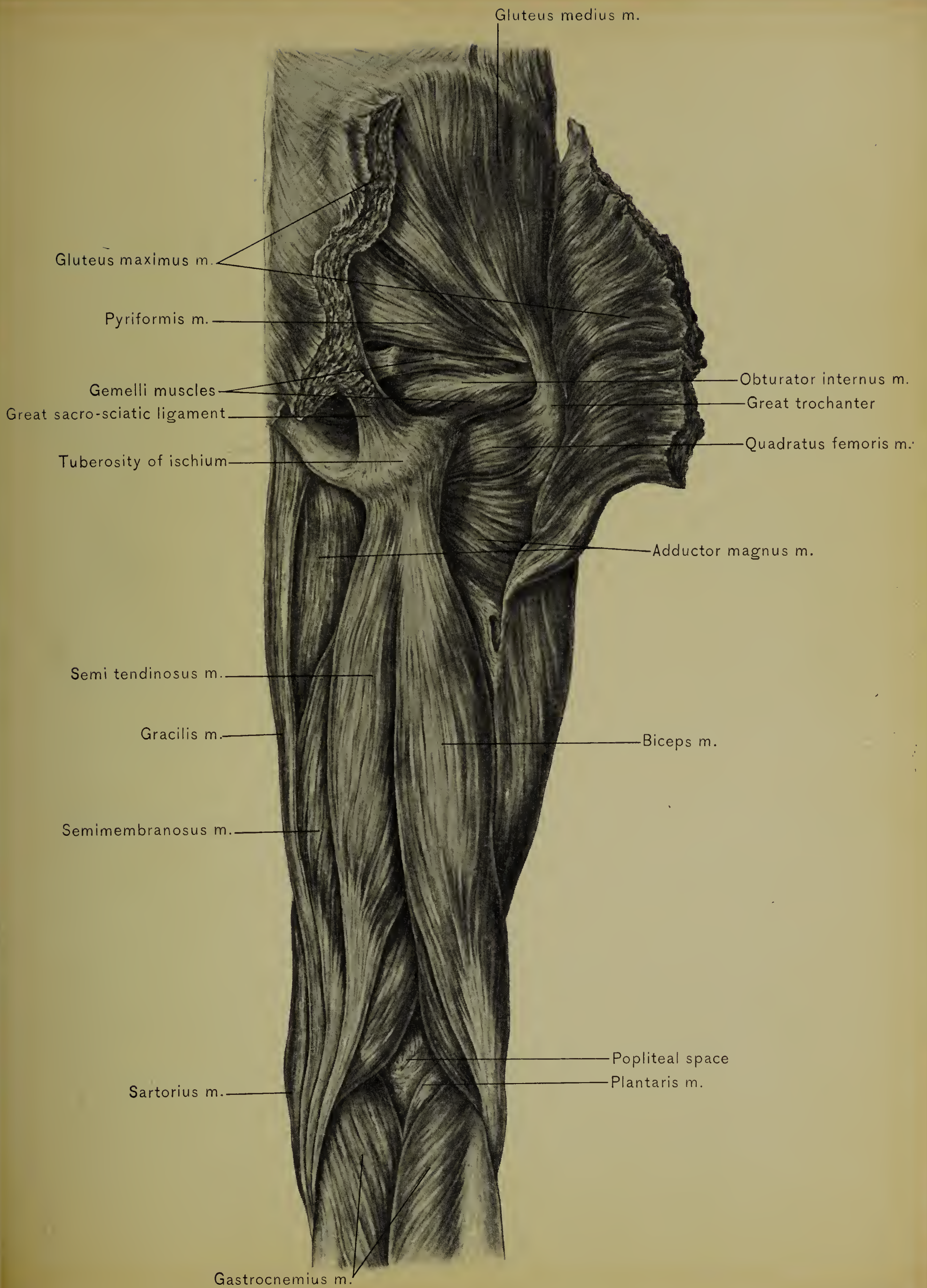
The flexor group of muscles, known as the **hamstrings**, extend from the pelvis to the leg, passing behind the hip- and knee-joints. This group comprises the biceps, the semitendinosus, and the semimembranosus muscles ; they all arise by strong tendons from the tuberosity of the ischium. By the divergence of these muscles below, the upper end of the popliteal space is formed.

The **biceps** is situated on the outer side of the thigh, and arises by two heads, a long and a short. The long head arises by a strong tendon from an impression on the back of the tuberosity of the ischium in common with the semitendinosus muscle ; the short head arises by fleshy fibers from the outer division of the linea aspera, between the adductor magnus and vastus externus muscles, and from the external intermuscular partition of the deep fascia ; this head extends from just below the insertion of the gluteus maximus downward to within a short distance of the condyle. The fibers of the short head join those of the long, and form a common tendon which is inserted into the outer side of the head of the fibula. At its insertion the tendon divides into two portions which embrace the external lateral ligament of the knee-joint, and gives off a strong expansion that extends forward to the outer tuberosity of the tibia and becomes continuous with the fascia of the leg.

NERVE SUPPLY.—It receives its nerve supply from the great sciatic nerve.

ACTION.—The biceps is a flexor of the knee and an external rotator of the leg. Taking its fixed point from below, it acts upon the hip-joint. It is superficial, except where it is covered by the gluteus maximus.

The **semitendinosus**, the smallest of the three flexor muscles, arises from the tuberosity of the ischium in common with the biceps ; also from the inner border of the tendon of the biceps above. Its fibers terminate in a tendon which rests upon the semimembranosus and passes over the internal lateral ligament of the knee-joint, assists in forming the inner boundary of the popliteal space, winds



MUSCLES OF BUTTOCK AND FLEXOR MUSCLES OF THE KNEE.

around the inner tuberosity of the tibia, and is inserted into the upper part of the inner surface of the tibia, below the tendon of the gracilis, and behind that of the sartorius. From its insertion an expansion is given off which becomes continuous with the deep fascia of the leg. At about its middle a tendinous intersection is usually observed. Like the biceps, it is covered above by the gluteus maximus muscle. The tendons of the gracilis, the semitendinosus, and the sartorius are separated from the internal lateral ligament of the knee-joint by a bursa.

NERVE SUPPLY.—Its nerve supply is derived from the great sciatic nerve.

ACTION.—The semitendinosus is a flexor as well as an internal rotator of the leg; taking its fixed point from below, like the biceps, it is an extensor of the hip.

The **semimembranosus muscle**, so called from the membranous appearance of its upper and lower surfaces, is situated along the back and inner side of the thigh between the two preceding muscles and the adductor magnus, upon which it lies. It arises from the tuberosity of the ischium, external to the semitendinosus and biceps, and is inserted by a thick tendon into the back part of the inner tuberosity of the tibia. Between the tendon and the inner head of the gastrocnemius and the internal condyle is a large synovial bursa. (See description of the popliteal bursæ.) From the tendon are derived three expansions: one passes beneath the internal lateral ligament (a synovial bursa intervening) to the groove at the back of the inner tuberosity of the tibia; one runs to the external condyle, forming the principal portion of the posterior ligament of the knee (ligament of Winslow); and the third one passes over the popliteus muscle to form its fascial covering.

NERVE SUPPLY.—It receives its nerve supply from the great sciatic nerve.

ACTION.—The semimembranosus, like the semitendinosus, is a flexor and internal rotator of the leg; when taking its fixed point from below, it is an extensor of the hip, and also takes a very important part in retaining the body in the erect position.

THE ACTION OF THE MUSCLES OF THE THIGH.—“To put the action of the muscles of the thigh on the pelvis in the clearest point of view, let us suppose we are standing upon one leg; the bones of the lower extremity represent a pillar which supports the weight of the trunk on a ball-and-socket joint; the weight is nicely balanced on all sides, and prevented from falling by four groups of muscles” (Holden). In front are the rectus femoris and sartorius; on the inner side, the adductors; on the outer side, the gluteus medius and minimus; and behind, the hamstring and gluteus maximus muscles.

NERVE SUPPLY OF THE FLEXORS.—The flexor group of muscles receives its nerve supply from the great sciatic, and its blood supply from the perforating branches of the deep femoral and the muscular branches of the popliteal.

The **great sciatic nerve** leaves the gluteal region under cover of the gluteus maximus, descends upon the adductor magnus and beneath the long head of the biceps, and runs along the outer border of the semimembranosus. It divides about the middle of the thigh into its two terminal divisions, the external and internal popliteal nerves, both of which have been described in the popliteal space.

THE BACK OF THE LEG.

DISSECTION.—Extend the incision made in the dissection of the popliteal space along the middle of the calf to the sole of the foot, where a transverse incision is to be carried around the heel, extending along the sides of the foot. Reflect the skin and expose the superficial fascia.

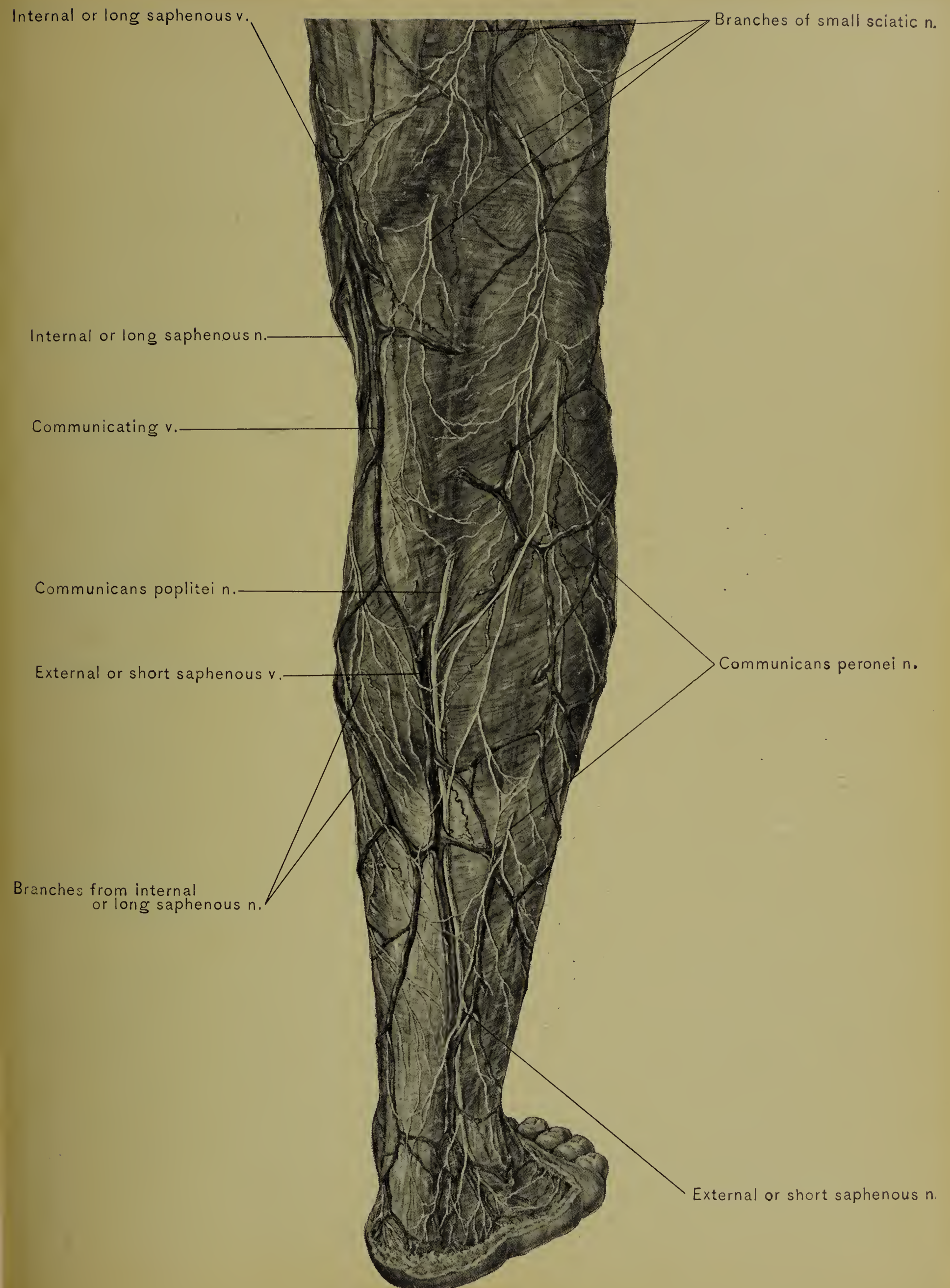
In the superficial fascia of the leg are situated the superficial vessels and nerves. The long and short saphenous veins, and the long saphenous, the short saphenous, and the communicans peronei nerves are the most important.

On the inner side of the leg are the **long saphenous vein** and the **long saphenous nerve**, both of which have been described in the dissection of the front of the leg.

In the middle of the back of the leg is seen the **short saphenous vein**. It begins on the outer side of the dorsum of the foot in the dorsal venous arch and passes behind the external malleolus to reach the leg. It leaves the superficial fascia at the lower part of the popliteal space by piercing the popliteal fascia, and empties into the popliteal vein. In the lower part of the leg it is accompanied by the short saphenous nerve, and in the upper part by the small sciatic. Both the long and short saphenous veins receive numerous veins in their course. They are guarded by several valves.

The cutaneous nerves seen in the superficial fascia are branches of the internal cutaneous, upon the inner side and above; of the long saphenous, upon the inner side and below; of the small sciatic, in the middle and above; of the short saphenous, below; and, on the outer side, branches of the communicans peronei nerve.

The **short saphenous nerve**, which is formed by a branch of the internal popliteal (the communicans poplitei), and a branch of the external popliteal (the communicans peronei), pierces the deep fascia at about the middle of the leg and accompanies the short saphenous vein down the leg behind the external malleolus. At the lower part of the leg the nerve runs external to and a little in front of the tendo Achillis. An incision for exposing the nerve should be made parallel with and a little in advance of the outer margin of the tendo Achillis, and behind the upper part of the external malleolus.



CUTANEOUS VESSEL AND NERVES, BACK OF LEG.

In some cases the **communicans peronei nerve**, a branch of the external popliteal, instead of joining the short saphenous nerve where it pierces the deep fascia, descends to the heel as a separate nerve.

Cutaneous arteries accompany the superficial veins and nerves of the leg.

DISSECTION.—Reflect the superficial fascia, after making incisions similar to those made in reflecting the skin, when the deep fascia will be brought into view.

The deep fascia upon the back of the leg is continuous with the popliteal fascia above and with the external and internal annular ligaments of the ankle-joint below. Above, it receives offsets from the tendons of the biceps, semimembranosus, semitendinosus, sartorius, and gracilis muscles. These muscles, by their contraction, make tense the fascia of the leg. A transverse partition of the deep fascia, called the *deep transverse fascia*, extends across the leg between the superficial set of muscles (the gastrocnemius, plantaris, and soleus) and the deep set (the tibialis posticus, flexor longus digitorum, and flexor longus pollicis), and covers, also, the main vessels of the back of the leg. It is stronger below, where it joins the internal annular ligament at the ankle, than it is above. In the ligation of the posterior tibial artery the inner edge of this transverse partition of the fascia constitutes a very important landmark. The deep fascia of the leg is thinner behind than in front.

DISSECTION.—Reflect the deep fascia by incisions corresponding to those made through the skin and superficial fascia, care being taken not to destroy the short saphenous nerve. This will expose the superficial muscles of the back of the leg.

The muscles of the back of the leg are divided into two sets—a superficial and a deep. The superficial set comprises the gastrocnemius, the plantaris, and the soleus. The deep set includes the popliteus, the flexor longus digitorum, the tibialis posticus, and the flexor longus hallucis.

The **gastrocnemius muscle** arises by two heads from the back of the condyles of the femur. The inner head, the larger, arises from a depression at the upper part of the internal condyle behind the insertion of the tendon of the adductor magnus. The outer head arises from the upper and back part of the external condyle above the origin of the popliteus. The two heads descend and form the two bellies of the muscle, the inner being the larger. Below the middle of the leg they, with the soleus, terminate in the common tendon of insertion—the tendo Achillis. The heads of the gastrocnemius assist in forming the lower lateral boundaries of the popliteal space. Between the inner head and the internal condyle of the femur there is a bursa. In the outer head is commonly found a piece of fibrous cartilage, or in some cases a sesamoid bone. The deep surface of the muscle is in relation with the popliteus, the plantaris, and the soleus muscles,

the popliteal vessels, and the internal popliteal nerve. Two large branches of the popliteal artery (the sural) enter the heads of the muscle to supply it.

NERVE SUPPLY.—The nerve supply is derived from the internal popliteal nerve.

ACTION.—The gastrocnemius is an extensor of the ankle. When taking its fixed point at the os calcis, it is a flexor of the knee-joint.

DISSECTION.—The two heads, at the junction with the belly of the muscle, are to be cut across and the two portions of the muscle reflected. This will expose the under surface of the gastrocnemius and the upper surface of the soleus,—both of which are covered with a glistening aponeurosis,—the plantaris tendon, and the vessels and nerves entering the heads of the muscle.

The **plantaris** is a very small muscle, has the longest tendon of any muscle in the body, and is representative of the palmaris longus of the forearm. It arises from the rough line leading from the linea aspera to the external condyle of the femur and from the posterior ligament of the knee-joint. Its belly is about two inches (5.0 centimeters) in length and terminates in a tendon which passes obliquely between the gastrocnemius and soleus muscles and runs along the inner border of the tendo Achillis to be inserted into the os calcis. Occasionally its tendon is inserted into the deep fascia of the leg or into the tendo Achillis.

NERVE SUPPLY.—Its nerve supply is from the internal popliteal nerve.

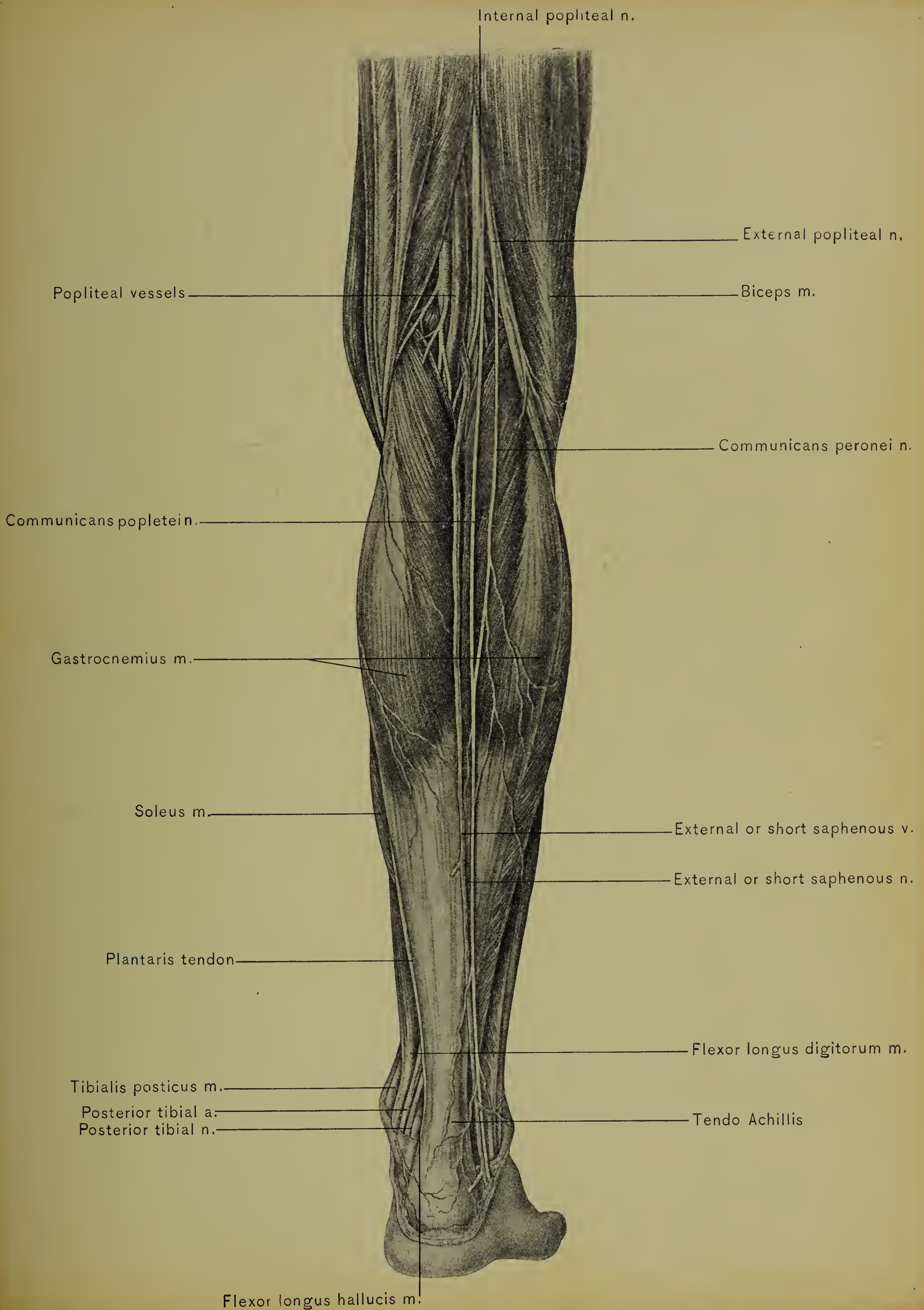
ACTION.—It assists the gastrocnemius, being an extensor of the ankle if the foot be not fixed, and a flexor of the knee when acting from its point of insertion. This muscle is sometimes absent.

The **soleus** is a large flat muscle arising by two heads. The outer head arises from the posterior surface of the head of the fibula and from the upper part of the posterior and internal surface of the shaft of the same bone. The inner head arises from the oblique line of the tibia, from the middle third of the inner border of the tibia, and from a tendinous arch between the tibia and fibula. Beneath this arch pass the posterior tibial vessels and nerve. Its fibers terminate in a broad tendon, which, with the tendon of the gastrocnemius, forms the *tendo Achillis*. The under surface of the muscle, like the upper, is covered by an aponeurosis.

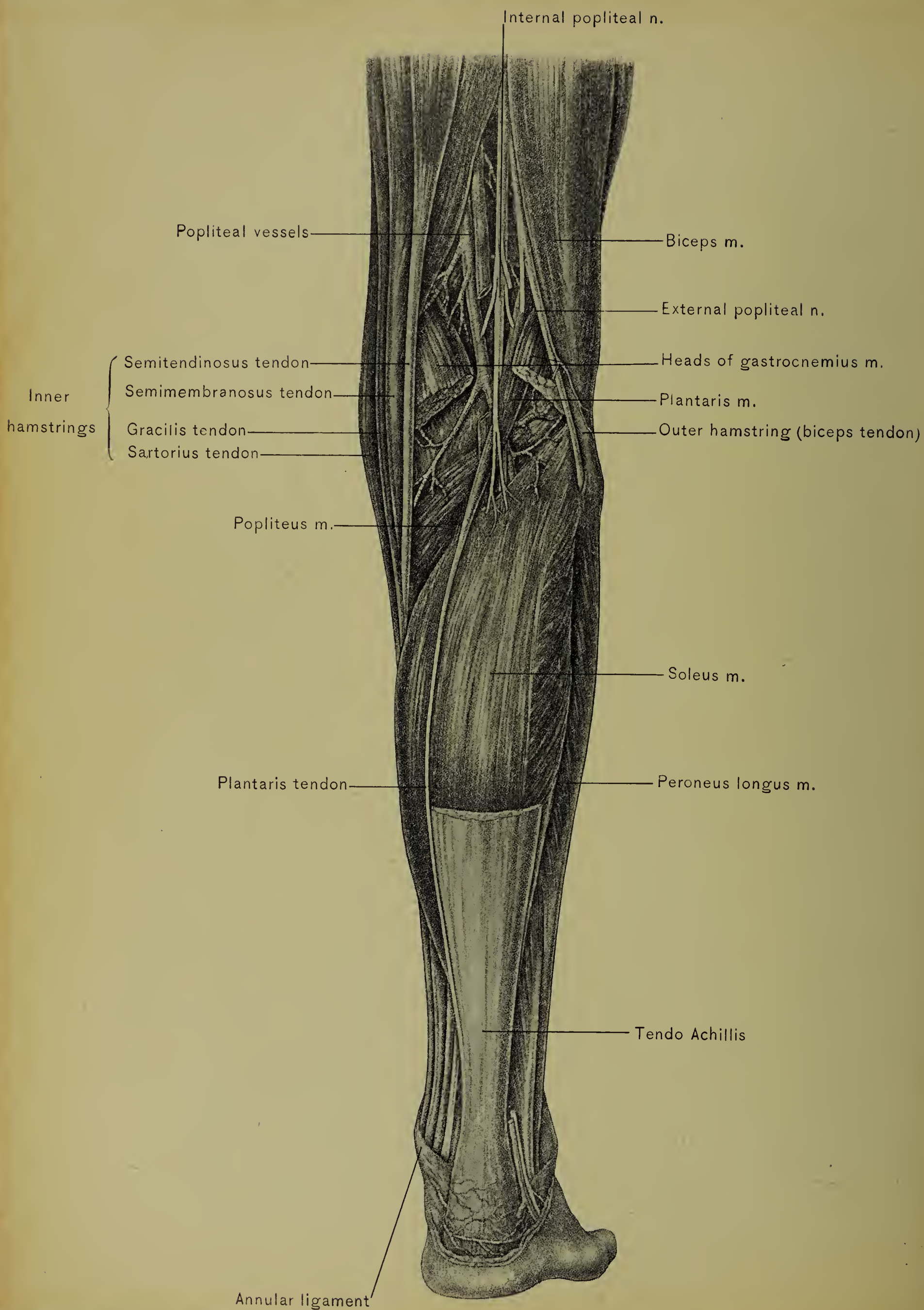
NERVE SUPPLY.—The nerve supply is derived from the posterior tibial.

ACTION.—It is an extensor of the ankle.

The **tendo Achillis** is formed by the union of the tendons of the gastrocnemius and soleus muscles. It begins about the middle of the leg, and at first is of considerable size, but gradually becomes narrower and thicker as it descends. This tendon is divided in certain forms of club-foot, as, for example, talipes



GASTROCNEMIUS MUSCLE.



SOLEUS AND PLANTARIS MUSCLE.

equinus. The most convenient as well as the safest place for division is about an inch and a half (3.75 centimeters) above its insertion into the tuberosity of the os calcis. Between the tendon and the bone is a large quantity of fat, and between the mass of fat and bone is a synovial bursa. Several cases are reported of rupture of the gastrocnemius muscle during violent exertion. The tendo Achillis has also been ruptured under such circumstances. In contact with the outer side of the tendon, but superficial to it, are the short saphenous vein and short saphenous nerve.

DISSECTION.—The inner and outer heads of the soleus muscle are to be detached, when will be exposed the tibia and fibula, and the transverse inter-muscular partition of the deep fascia of the leg. The fascia covering the popliteal muscle, and the deep transverse fascia of the leg, are then to be removed, when the posterior tibial vessels and nerve, the peroneal vessels, and the deep muscles will be brought into view.

The **posterior tibial artery**, the larger of the two terminal divisions of the popliteal, commences at the lower border of the popliteus muscle and extends down the leg between the superficial and deep set of flexors. It rests upon the tibialis posticus muscle in the upper two-thirds of its course, and upon the flexor longus digitorum muscle and the tibia in the lower part. Reaching the interval between the internal malleolus and the os calcis, it passes beneath the internal lateral ligaments and ends in the sole of the foot, dividing beneath the origin of the abductor pollicis into the internal and external plantar arteries. In the upper part of the leg the artery is deeply seated, making its ligation difficult; in the lower part of the leg it is more superficial, being covered only by the integument and superficial and deep fasciæ. Above the internal malleolus it runs parallel with the tendo Achillis; behind the internal malleolus it is between the tendon of the flexor longus digitorum and the flexor longus pollicis. It is accompanied by two veins, the *venæ comites*, and by the posterior tibial nerve, which is about the size of the musculo-spiral. At its commencement and in the upper part of the leg the nerve lies to the inner side of the artery. It then crosses beneath the vessel to reach its outer side, and for the remainder of its course lies external to and behind the artery. Behind the internal malleolus the nerve lies between the artery and the tendon of the flexor longus pollicis muscle. A line drawn from the middle of the popliteal space to the point midway between the internal malleolus and the os calcis will represent the course of the artery.

Accompanying the posterior tibial artery are the two posterior tibial veins (*venæ comites*). They are formed by the union of the internal and external plantar veins. They receive the peroneal veins; at the lower border of the popliteus muscle they are joined by the anterior tibial veins to form the popliteal vein.

LIGATION OF THE POSTERIOR TIBIAL ARTERY.—In the ligation of the upper third of the artery an incision is made along the inner edge of the tibia and the skin, and the superficial and deep fasciæ are divided, care being taken to avoid the long saphenous vein and nerve. This opens up the interval between the gastrocnemius and soleus muscles, occupied by the plantaris tendon; this is not to be mistaken for the interval between the transverse intermuscular septum and the posterior tibial muscle, occupied by the posterior tibial vessels and nerves, which structures are not exposed until the inner head of the soleus is separated from the tibia, and the transverse intermuscular septum is incised. The inner head of the soleus is then cut from the tibia and reflected, exposing the transverse partition of the deep fascia extending from the inner to the outer side of the leg between the superficial and deep set of muscles. This must be divided, when the posterior tibial vessels and nerves are exposed.

The posterior tibial artery rarely requires ligation in its upper third, except in cases of punctured wound from the front of the leg, and of traumatic aneurysm of the vessel low down. In cases of injury with bleeding from the posterior tibial, both ends of the vessel should be exposed and tied.

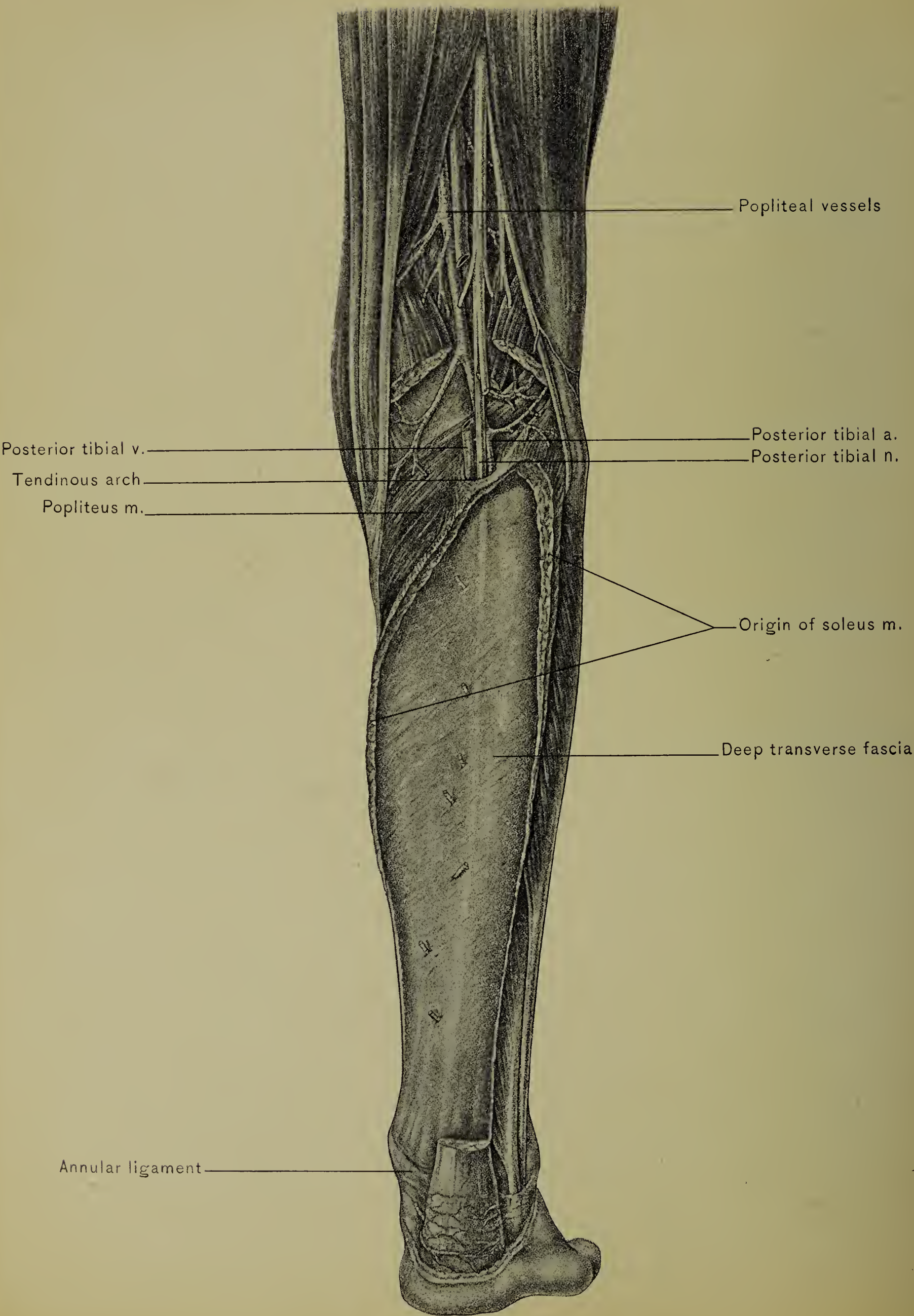
The branches of the posterior tibial artery are the peroneal, the muscular, the nutrient, the communicating, the internal calcanean, the internal malleolar, and the terminal branches, the external and internal plantar arteries.

The **peroneal artery** is the largest branch of the posterior tibial, and is often as large as the main trunk. It arises about an inch (2.5 centimeters) below the bifurcation of the popliteal artery, and passes down the leg close to the fibula. Above, it rests upon the tibialis posticus muscle, and below upon the interosseous membrane and the tibio-fibular articulation, being overlapped, where it comes in contact with the fibula, by the inner border of the flexor longus pollicis. It passes to the outer side of the heel, where it anastomoses with the malleolar and external plantar arteries.

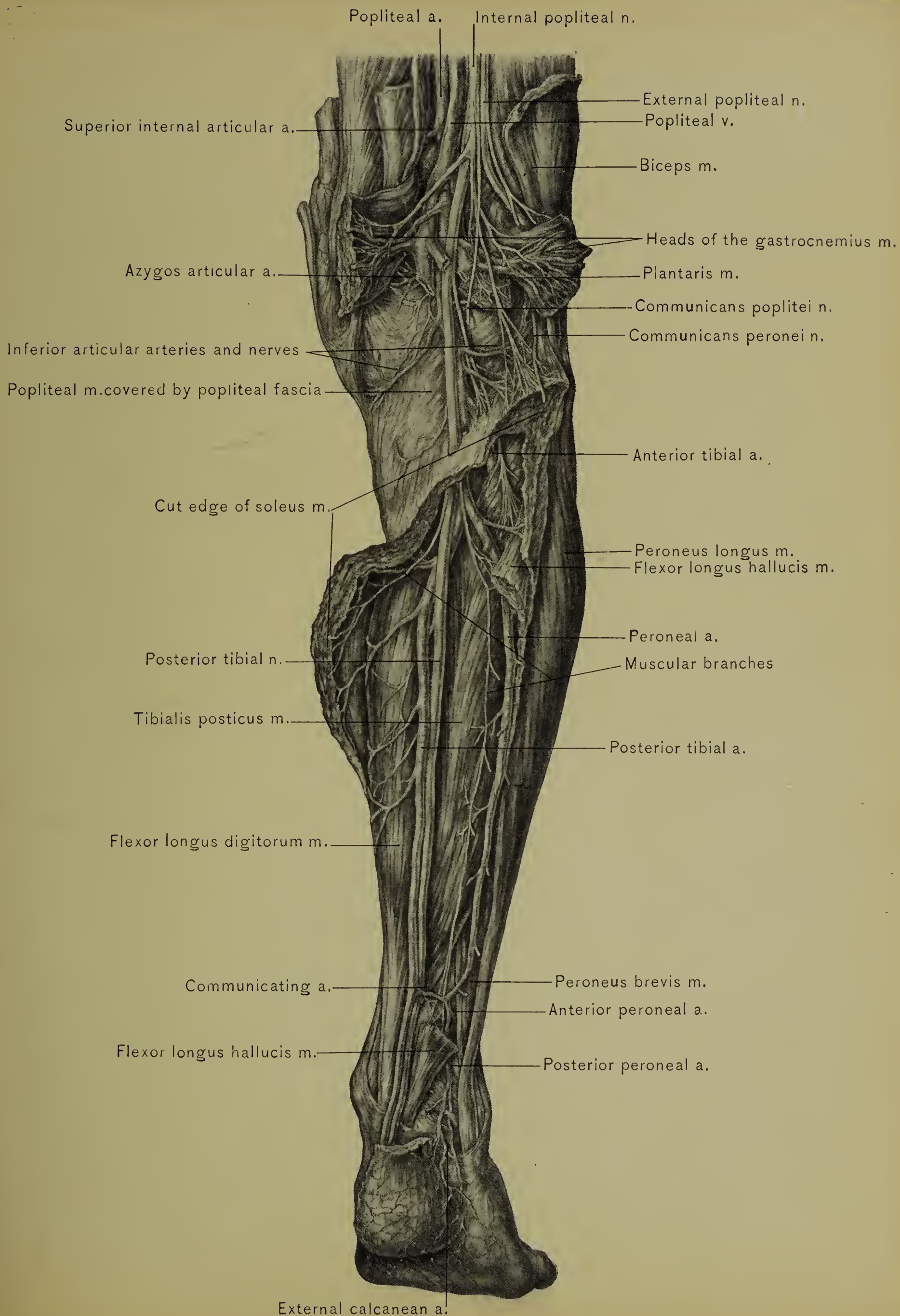
The branches of the peroneal artery are the anterior peroneal, the nutrient, the muscular, the communicating, the cutaneous, the external calcanean, and the terminal or posterior peroneal.

The *anterior peroneal artery* is given off from the peroneal artery a short distance above the ankle. It passes through the interosseous membrane to reach the dorsal and external part of the foot, where it anastomoses with the tarsal and external malleolar arteries. It is covered by the peroneus tertius muscle and passes beneath the horizontal portion of the anterior annular ligament. In cases where the anterior tibial artery is small and terminates at the ankle, the anterior peroneal artery is large and takes the place of the dorsalis pedis.

The *nutrient artery of the fibula* is a branch of the peroneal.



DEEP TRANSVERSE FASCIA.



The *muscular branches* of the peroneal artery supply the deep muscles and the soleus.

The *communicating branches* anastomose in front of the tendo Achillis with the communicating branch of the posterior tibial.

The *cutaneous branches* supply the skin over the outer side of the leg.

The *external calcanean artery* is given off below the origin of the anterior peroneal artery and is distributed over the outer aspect of the os calcis.

The *terminal branch*, or *posterior peroneal*, is the continuation of the peroneal artery and anastomoses with the malleolar and calcanean arteries.

LIGATION OF THE PERONEAL ARTERY.—In the ligation of the peroneal artery the outer head of the soleus muscle is to be detached, and the external border of the deep transverse fascia divided. This opens the space between the partition of the fascia and the tibialis posticus muscle and exposes the peroneal vessels.

The *muscular branches* of the posterior tibial artery supply the flexor longus digitorum, flexor longus hallucis, and soleus muscles.

The *nutrient artery of the tibia* is a branch of the posterior tibial, given off near its commencement.

The *communicating artery* arises from the posterior tibial at the lower part of the leg and passes transversely beneath the tendon of the flexor longus pollicis to anastomose with a branch of the peroneal, thus forming an arch.

The *internal calcanean arteries* are several branches which arise from the posterior tibial near the internal malleolus and which ramify over the posterior and inner aspects of the heel, anastomosing with the internal malleolar and peroneal arteries.

The *internal malleolar branches* run beneath the flexor longus digitorum and the tibialis posticus tendons to anastomose over the internal malleolus with the internal malleolar branch of the anterior tibial artery, and branches of the internal plantar and internal calcanean arteries.

The *plantar arteries* will be described with the foot.

The **posterior tibial nerve** is the continuation of the internal popliteal, and passes down the leg in company with the posterior tibial artery. In the upper part of the leg it lies to the inner side of the artery; it then crosses beneath the artery to its outer side, and for the remainder of its course it lies external to and behind the artery. In the lower part of the leg it runs parallel with the inner margin of the tendo Achillis as far as the interval between the internal malleolus and os calcis, where it divides into its two terminal branches—the internal and the external plantar nerves.

The branches of the posterior tibial nerve are the muscular, the cutaneous, and the two terminal branches—the external and internal plantar nerves.

The *muscular branches* supply the deep set of flexors.

The *cutaneous branch (internal calcanean)* arises from the nerve above the heel, pierces the internal annular ligament, and passes through the superficial fascia to supply the integument covering the inner and under surface of the heel and foot.

The *plantar nerves* will be described with the foot.

The deep muscles are the popliteus, the flexor longus digitorum, the flexor longus hallucis, and the tibialis posticus.

The **popliteus muscle** forms the lower part of the floor of the popliteal space, and extends obliquely from the outer side of the knee-joint to the inner part of the leg above. It arises by a strong tendon from a groove on the outer side of the external condyle of the femur, and from the posterior ligament of the knee-joint, its origin being covered by the tendon of the biceps and the external lateral ligament of the knee-joint. The tendon is within the capsule of the knee-joint and grooves the external semilunar fibro-cartilage, in this location receiving an investment from the synovial membrane of the knee. Hence it holds the same relation to the knee-joint as the long tendon of the biceps does to the shoulder-joint. Its fibers pass downward and inward and are inserted into the triangular surface of the tibia above the oblique line and into the fascia covering the surface of the muscle. It rests on the back of the tibia and on the superior tibio-fibular articulation. The fascia covering its surface is in relation with the popliteal vessels, the internal popliteal nerve, and the gastrocnemius and plantaris muscles. The popliteus muscle is important, first, because of the relation it bears to the capsular ligament of the knee-joint; second, because it forms a part of the floor of the popliteal space; and, third, because at its lower border the popliteal artery terminates by dividing into the anterior and posterior tibial arteries.

NERVE SUPPLY.—Its nerve supply is derived from the internal popliteal.

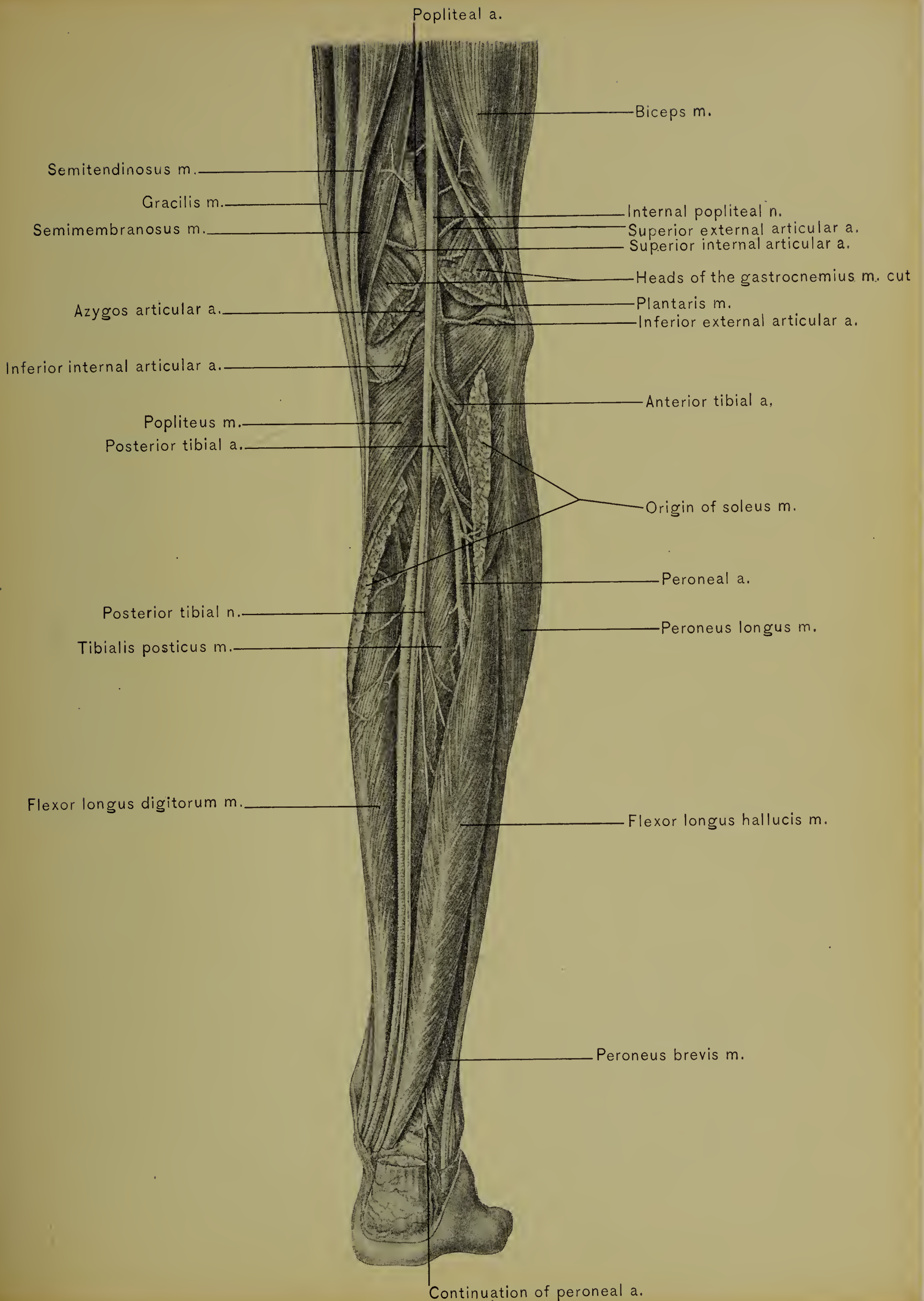
ACTION.—The action of the muscle is to flex the leg and rotate it inward.

The **flexor longus digitorum muscle** is situated on the inner side of the leg and arises from the posterior surface of the tibia below the oblique line to about three inches (7.5 centimeters) from the internal malleolus, and from the partition of the fascia between it and the tibialis posticus. The fibers terminate in a tendon on the inner side of the muscle which passes through a groove common to it and the tibialis posticus behind the internal malleolus. It enters the sole of the foot and divides into four tendons which are inserted into the terminal phalanges of the four outer toes. The posterior tibial vessels and nerve rest upon the upper surface of the muscle.

NERVE SUPPLY.—The nerve supply is derived from the posterior tibial nerve.

ACTION.—It flexes the phalanges and extends the ankles.

The **flexor longus hallucis muscle**, situated on the outer side of the leg, is



DEEP MUSCLES OF THE BACK OF THE LEG AND POSTERIOR TIBIAL ARTERY AND NERVE.

the largest and most superficial of the deep set of flexors. It arises from the lower two-thirds of the posterior surface of the fibula below the soleus, from the partition of the fascia between it and the peroneal muscles, from the lower part of the interosseous membrane, and from the aponeurosis over the tibialis posticus. Its fibers terminate in a tendon situated on the posterior surface of the muscle. The tendon passes through grooves—one on the back of the lower end of the tibia, one on the back of the astragalus, and one beneath the lower process (sustentaculum tali) of the os calcis—to reach the sole of the foot, where it is inserted into the last phalanx of the great toe. The depression along the outer side of the muscle contains the peroneal vessels; along its inner side are the posterior tibial vessels and nerve.

NERVE SUPPLY.—Its nerve supply is from the posterior tibial.

ACTION.—Its action is to flex the last phalanx of the great toe and to extend the ankle.

The **tibialis posticus muscle** is situated between the flexor longus digitorum and the flexor longus hallucis, and is the most deeply seated of all the flexor muscles, being partially concealed by the borders of the two preceding. It arises from the inner three-fourths of the posterior surface of the interosseous membrane by two processes between which the anterior tibial vessels pass, from about the middle three-fourths of the posterior surface of the tibia and the inner surface of the fibula, from the deep fascia covering it, and from the partition of fascia separating it from the adjacent muscles on either side. It terminates in a tendon in the lower fourth of the leg, which passes anterior to the tendon of the flexor longus digitorum, and accompanies it through the same groove behind the internal malleolus, but in a separate synovial membrane. It enters the sole of the foot to be inserted into the tuberosity of the scaphoid and the internal cuneiform bones. The tendon gives off a fibrous extension which is attached to most of the tarsal and metatarsal bones. The upper part of the muscle is beneath the intermuscular partition of fascia, and is overlapped by the flexor longus digitorum. The tendon lies close to and parallel with the inner edge of the tibia below. Its synovial sheath extends a little distance above the internal malleolus, and is opened in the operation of division of the tendon for the correction of talipes varus. In performing the operation of tenotomy on the tibialis posticus, the foot should be flexed to relax the tendon, and the tenotome introduced above the internal malleolus. The tenotome should hug the inner edge of the tibia until the interval between the tibia and the tendon is reached, when the blade of the instrument is turned at right angles to the bone and the tendon divided.

NERVE SUPPLY.—It receives its nerve supply from the posterior tibial nerve.

ACTION.—The action of the muscle is to extend the foot and turn it inward.

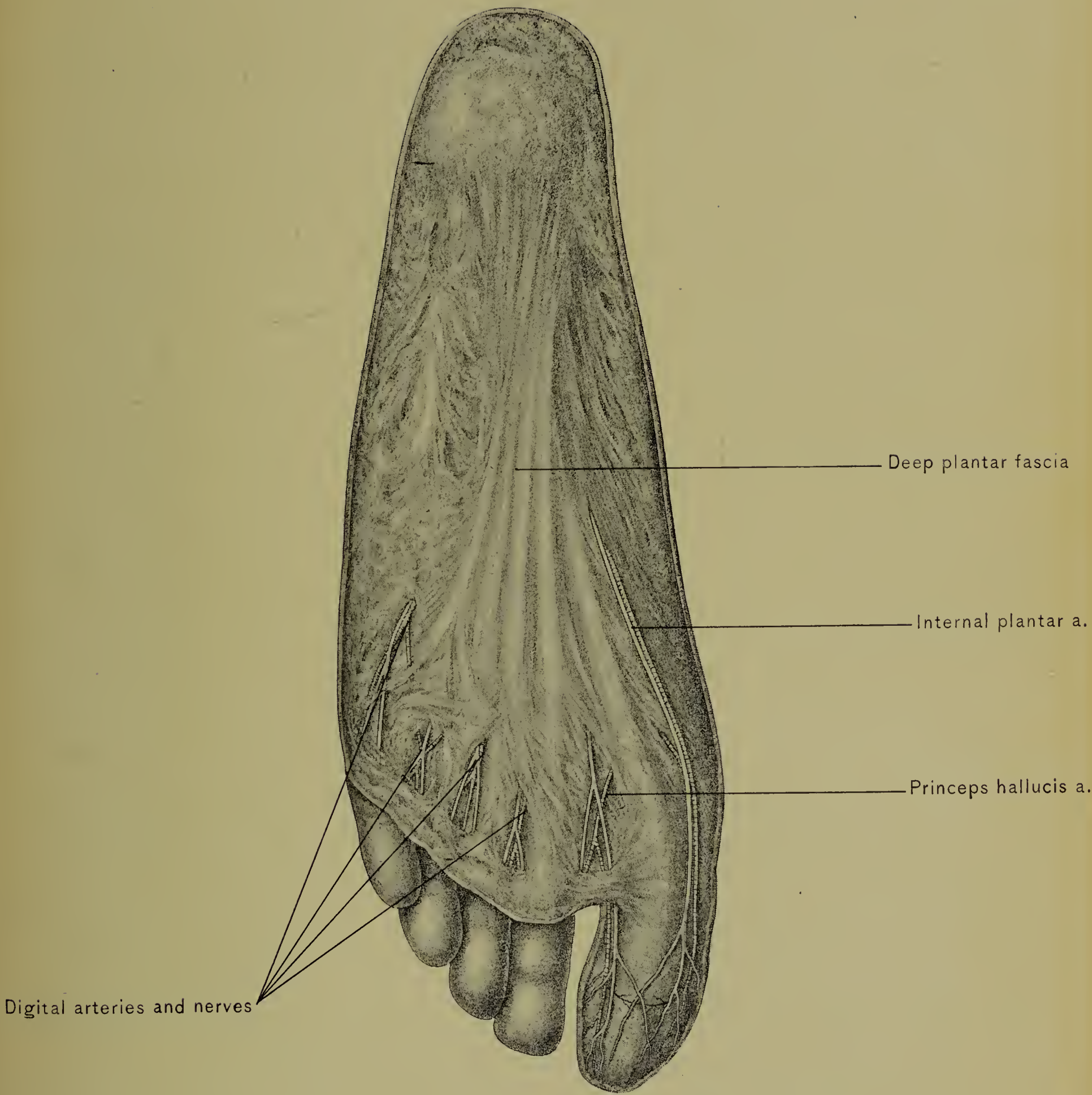
THE SOLE OF THE FOOT.

DISSECTION.—The leg is placed in the same position as in the dissection of the back of the leg, a block being placed under the ankle and the tissues of the sole of the foot put on the stretch by fixing the heel with hooks and by separating and fastening the toes. The incisions round the side to the heel made when dissecting the back of the leg are to be extended forward on the inner side to the ball of the great toe, and on the outer side to the ball of the little toe, at which points they are to be connected by a transverse incision across the sole of the foot at the clefts of the toes; from this, vertical incisions are to be made through the middle of the toes to their extremities. The skin, which is very thick and strong, is to be reflected from behind forward as one flap, thus exposing the superficial fascia.

The **superficial fascia** is seen as a dense layer of fat composed of granular masses and separated by strong fibrous septa. By this arrangement elastic pads are formed over the heel and the balls of the great and little toes. In each of these pads is a bursa; there is also one beneath the os calcis and one beneath the head of the metatarsal bone of the great toe and of the little toe. The fascia over the bony eminences is often three-fourths of an inch (1.9 centimeters) thick, more of it being distributed along the outer and the inner margin of the foot. In the middle of the sole it is not so abundant and the connection between the skin and the plantar fascia is more direct. The superficial fascia of the sole of the foot, as in the palm of the hand and the scalp, consists of but one layer.

The difference between the density of the superficial fascia of the sole of the foot and the laxity of the same tissue upon the dorsum of the foot is very great. This accounts for the great swelling on the dorsum in cases of diffuse inflammation and in conditions producing edema. In the commencement of general dropsy the first part of the body to show the swelling is often the back of the foot. In the sole of the foot, inflammatory affections and effusions produce but little external change, owing to the unyielding character of the parts involved. Collections of pus in the sole of the foot or heel tend to remain circumscribed; upon the dorsum they may form readily and extend rapidly; in the sole they cause intense pain, owing to the density of the tissues. In the fascia are some cutaneous branches of the plantar nerves, the cutaneous (internal calcanean) branch of the posterior tibial nerve, perforating branches of the plantar vessels, and a great number of lymphatics and veins.

DISSECTION.—The superficial fascia is to be removed in the same manner as was the skin, when the deep fascia (the plantar fascia) will be brought into view.



DEEP PLANTAR FASCIA.

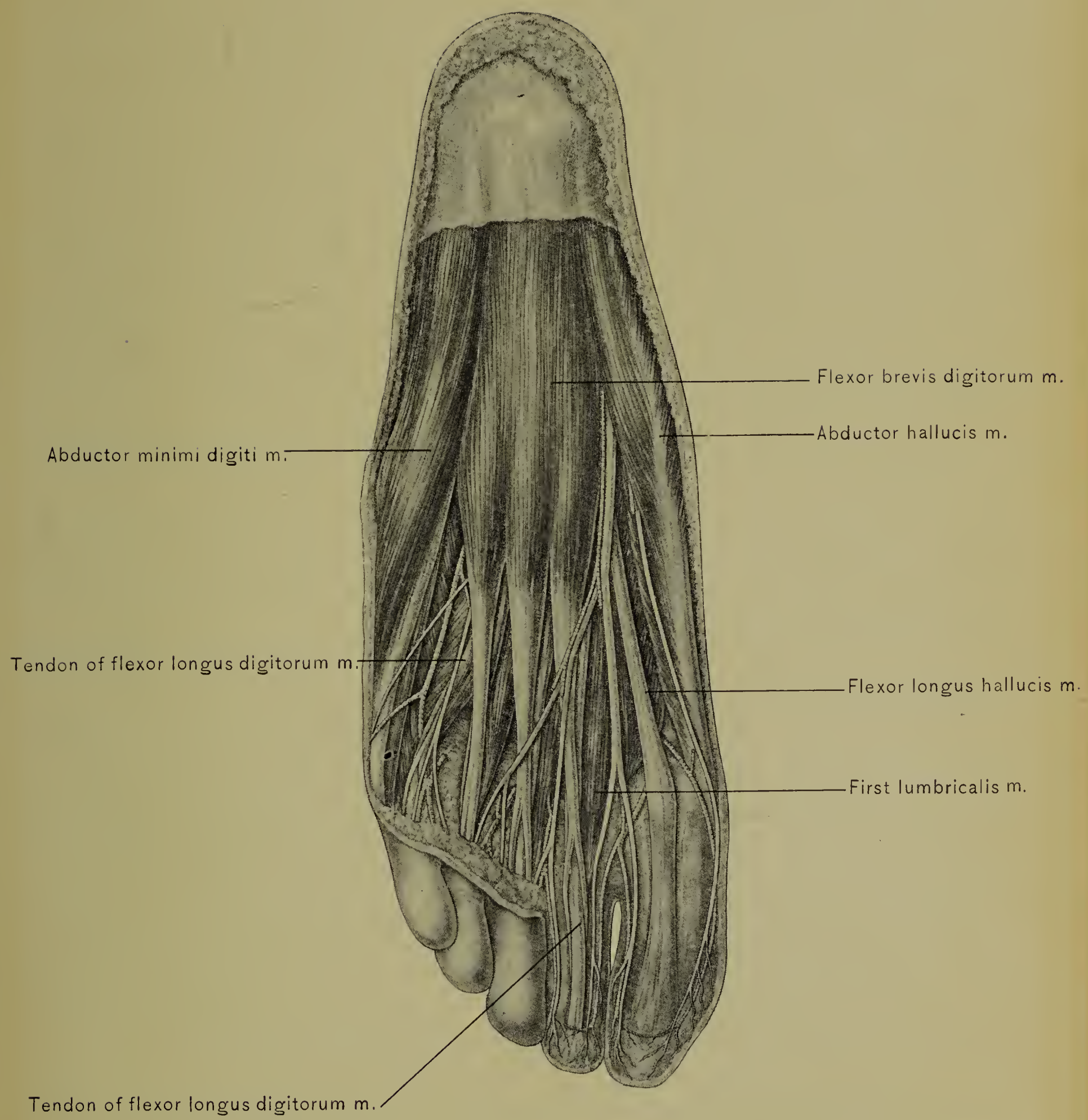
The **plantar fascia**, holding, as it does, so important a relation to some of the forms of deformity known as club-foot, as well as to operations for the relief of the deformity, is to be studied most carefully. It is a very dense and strong tissue of a pearly white color. It extends from the under surface of the back part of the os calcis to the heads of the metatarsal bones. It consists of three portions: a central or main portion, which is extremely dense and strong, and of special surgical importance; and two lateral portions, the inner one of which is quite thin and of little surgical significance. The outer lateral portion is continuous with the fascia of the back of the foot. It forms a very thick band between the os calcis and the metatarsal bone of the little toe and covers the abductor minimi digiti. The inner portion covers the abductor hallucis muscle; posteriorly it is continuous with the internal lateral ligament and internally with the fascia of the back of the foot. The central portion is triangular in shape, with its apex above, at the os calcis, and its base below. The base of the central portion near the head of the metatarsal bones divides into five processes, between which the digital vessels and nerves and the tendons of the lumbrical muscles pass. Each of the five processes divides opposite the metatarsophalangeal joints into two slips which embrace the sides of the flexor tendons and are inserted into the sides of the metatarsal bones, into the transverse metatarsal ligaments, and into the sheaths of the extensor tendons. In this way arches are formed for the passage of the flexor tendons in reaching the toes. At the point of division of the fascia into processes, and at the point of division of the processes, numerous transverse fibers bind them together and connect them with the skin, in this way serving to increase the strength of the fascia at these points. At the point of junction of the central portion with the two lateral portions of the fascia, two strong vertical septa, broader in front than behind, pass into the foot and separate the middle plantar group from the internal and external group of muscles; from these, again, inner transverse septa are derived which separate the various layers of muscles in this region. In the folds of the skin between the toes are ligamentous fibers, *the transverse ligaments of the toes*, which run from one side of the foot to the other, answering the same purpose as the ligaments of the hand. The central portion of the fascia assists greatly in supporting the antero-posterior arch of the foot, which it tends to maintain in the same manner as the bowstring maintains the arch of the bow. The sinking of the arch that occurs in flat-foot (*talipes planus*) is attended with a marked yielding of this portion of the fascia. The plantar fascia is often found much contracted in certain forms of club-foot, such as *talipes equinus* and congenital *talipes varus*. The term *talipes arcuatus* is applied to a deformity that depends mainly or entirely upon the contraction

of the plantar fascia. The best place to divide this fascia is about an inch (2.5 centimeters) in front of its attachment to the os calcis, this being its narrowest part. A collection of pus beneath the fascia will be very closely bound down and will extend in any direction other than through the fascia itself. Such collections cause intense pain and often much destruction of tissue before they are discharged. They may open upon the back of the foot, between the toes, or may extend along the tendons of the ankle. In the fascia are small holes through which pass branches of the plantar arteries to the superficial fascia and integument; these openings are filled in with fat. In exceptional cases the pus from a deep abscess will extend through these openings and spread out into the superficial fascia. Such an abscess will have, therefore, two cavities communicating by a small opening, forming the *abscess en bissac*, or *boutonnière en chemise*, of the French. The vertical portions of the deep fascia are too feeble to greatly obstruct the progress of a deep-seated abscess.

DISSECTION.—The plantar fascia is now to be removed by dividing it transversely about an inch (2.5 centimeters) in front of the os calcis and reflecting it, care being taken in separating it from the flexor brevis digitorum muscle, to which it gives origin, and avoiding, in front, the digital vessels and nerves between its processes. The parts exposed in this dissection are the flexor brevis digitorum muscle, occupying the center of the sole of the foot, and its four tendons,—the tendons of the flexor longus digitorum, associated with which are the lumbrical muscles,—and the terminal part of the digital arteries. Upon the inner side of the foot is seen the abductor hallucis, and upon the outer side the abductor minimi digiti. Occupying the grooves between the flexor brevis digitorum and the abductor hallucis on the inner side, and the flexor brevis digitorum and the abductor minimi digiti upon the outer side, are the internal and external plantar arteries and nerves respectively.

The muscles in the sole of the foot consist of four layers. The *superficial layer* comprises the flexor brevis digitorum, the abductor hallucis, and the abductor minimi digiti; the *second layer* comprises the flexor accessorius and the lumbricales; the *third layer*, the flexor brevis hallucis, the adductor hallucis, the flexor brevis minimi digiti, and the transversus pedis; and the *fourth layer*, the interossei, three in number.

The **flexor brevis digitorum muscle** lies immediately beneath the central part of the plantar fascia and arises from the under surface of the os calcis between the abductor hallucis and the abductor minimi digiti from the central portion of the plantar fascia and from the intermuscular septa between it and the muscles on either side. It passes forward and divides into four tendons which lie superficial to those of the flexor longus digitorum and end in the four outer toes. The



FIRST LAYER OF MUSCLES OF THE SOLE OF THE FOOT.

sheaths binding the tendons to the phalanges are to be laid open, when the tendons of the flexor brevis will be seen to divide into two slips opposite the middle of the first phalanx, to allow the tendons of the flexor longus digitorum to pass through. The two slips unite once more, then again divide, and are inserted into the sides of the second phalanges. In their insertion these tendons resemble the tendons of the flexor sublimis digitorum in the hand.

NERVE SUPPLY.—The flexor brevis digitorum is supplied by the internal plantar nerve.

ACTION.—The action is to flex the second phalanges of the toes, and thus to assist the flexor longus digitorum in walking. By continuing its action it causes flexion of the metatarso-phalangeal and medio-tarsal joints.

The **abductor hallucis muscle** lies along the inner side of the foot. It arises by two heads. The *outer head* arises from the inner tubercle on the under surface of the os calcis, from the inner portion of the plantar fascia, and from the intermuscular septum between it and the flexor brevis digitorum. The *inner head* arises from the internal annular ligament, and from the tendinous insertion of the tibialis posticus muscle. Between these two heads, and under the arch formed by their junction, pass the posterior tibial vessels. Its fibers terminate in a tendon which, with the innermost tendon of the flexor brevis hallucis, is inserted into the inner side of the base of the first phalanx of the great toe.

NERVE SUPPLY.—It receives its nerve supply from the internal plantar nerves.

ACTION.—Its action is to draw the great toe away from the middle line of the foot and to flex the first phalanx.

The **abductor minimi digiti muscle** lies along the outer side of the foot and arises by a very strong and broad origin from the outer tubercle on the under surface of the os calcis, from the plantar fascia, from the external intermuscular septum between it and the flexor brevis digitorum, and from the long plantar ligament. Its fibers terminate in a tendon which, with the tendon of the flexor brevis minimi digiti, is inserted into the outer side of the base of the first phalanx of the little toe.

NERVE SUPPLY.—It receives its nerve supply from the external plantar nerve.

ACTION.—Its action is to draw the little toe outward from the median line of the foot and to flex its first phalanx.

DISSECTION.—The superficial muscles are to be divided at their origin and reflected downward. This will bring into view the plantar vessels and nerves, the tendons of the flexor longus digitorum, the flexor longus hallucis, the flexor accessorius, the lumbricales, the flexor brevis hallucis, the flexor brevis minimi digiti,

the long plantar ligament, the terminal portion of the tendons of the *tibialis anticus* and *tibialis posticus*, and a portion of the *peroneus longus*.

The **posterior tibial artery** enters the sole of the foot between the two heads of origin of the *abductor hallucis* muscle and divides beneath the *os calcis* into its two terminal branches, the external and internal plantar arteries.

The **external plantar artery**, the larger of the two, and the principal artery of the sole of the foot, forms, with the communicating branch of the *dorsalis pedis*, the plantar arch. It passes obliquely outward and forward to the base of the metatarsal bone of the little toe, accompanied by the external plantar nerve, and rests upon the upper surface (in the present position) of the *flexor accessorius* muscle. At the anterior part of the foot it sinks deeply and runs obliquely inward across the bases of the four outer metatarsal bones to the interval between the base of the metatarsal bones of the great and second toes, where it anastomoses with the communicating branch from the *dorsalis pedis* artery, thus completing the formation of the **plantar arch**. In the first half of its course—that is, from the inner side of the *os calcis* to the base of the metatarsal bone of the little toe—the artery is placed beneath the *abductor hallucis*, and then beneath the *flexor brevis digitorum* and the *flexor accessorius*, and externally between the *flexor brevis digitorum* and the *abductor minimi digiti* muscles. In the latter situation it is most superficial, being covered only by the skin and by superficial and deep fascia. In the last half of its course it lies deeply, and will be examined after the dissection of the third layer of the muscles. It is accompanied by its *venæ comites* and the external plantar nerve.

The branches of the external plantar artery are: the muscular, cutaneous, calcanean, anastomotic, articular, posterior perforating, and digital.

The *muscular branches* are given off to the adjacent muscles throughout the course of the artery.

The *cutaneous branches* pass between the middle and outer portions of the plantar fascia, to supply the skin.

The *calcanean branches* run over the inner surface of the *os calcis* and anastomose with branches of the internal calcanean branch of the posterior tibial artery.

The *anastomotic branches* anastomose with the tarsal and metatarsal branches of the *dorsalis pedis* artery over the outer side of the foot.

The *articular branches* are given off from the deep plantar arch opposite the digitals, and supply the tarsal joints. They are usually three in number.

The *posterior perforating branches*, three in number, communicate, through the second, third, and fourth spaces, between the heads of the corresponding dorsal interosseous muscles, with the first, second, and third interosseous arteries.

The *digital branches*, usually four in number, are named, in the order in which they are given off, from without inward, first, second, third, and fourth.

The first or outermost digital artery runs along the outer side of the foot and little toe; the inner digitals pass along the interosseous spaces and between the primary divisions of the central portion of the plantar fascia to reach the clefts of the toes, where each divides into two branches for the supply of the adjacent sides of the toes. The inner side of the second and both sides of the first toe are supplied by the princeps hallucis artery, which is given off at the point of junction of the external plantar with the communicating branch of the dorsalis pedis artery. This vessel, immediately after its origin, divides into two branches, the inner supplying the inner side of the great toe, and the outer passing over the interosseous space to the web between the great and second toes, where it divides into two branches for the supply of the adjacent sides of the first and second toes. At the bifurcation each digital artery gives off a branch which ascends through the forepart of the interosseous space, anastomosing with the interosseous branches of the metatarsal artery. These vessels are known as the *anterior perforating arteries*. The four outer digital branches of the arch resemble the digital branches of the superficial palmar arch. The digital branch to the great toe, or fifth digital, would represent the princeps pollicis and the radialis indicis arteries.

The **internal plantar artery**, the remaining terminal division of the posterior tibial, is very much smaller than the external plantar. It passes forward between the flexor brevis digitorum and the abductor hallucis muscles to the base of the great toe, being overlapped by the latter muscle in the first portion of its course. It then passes along the inner side of the great toe, much diminished in size, and anastomoses with the digital arteries, derived from the princeps hallucis artery. It is accompanied by its *venæ comites* and the internal plantar nerve.

The branches of the internal plantar artery are the muscular, cutaneous, articular, anastomotie, and superficial digital, and are small and not very regular in origin and distribution.

The **posterior tibial nerve**, like the posterior tibial artery, enters the sole of the foot under the origin of the abductor hallucis muscle and divides into its two terminal divisions—the internal and external plantar. Before it enters the sole of the foot it gives off a few branches to the ankle-joint, and the internal calcanean or calcaneo-plantar cutaneous branch, which pierces the internal lateral ligament and supplies the skin and fascia over the heel. It has been previously mentioned.

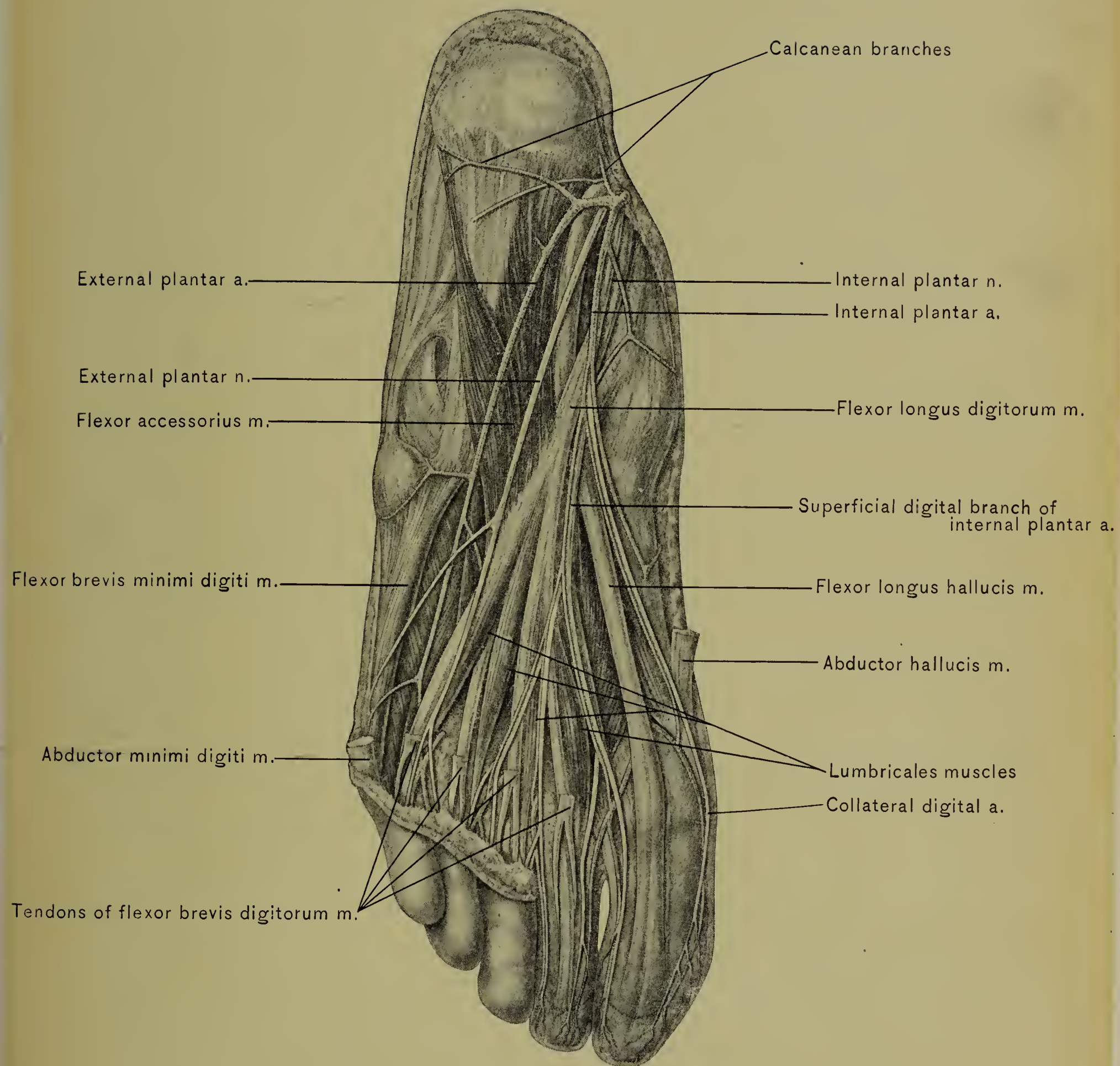
The **external plantar nerve** is the smaller of the two, and accompanies the external plantar artery in the first half of its course, having, therefore, the same relations as the artery. When it reaches the interval between the flexor accessorius and the abductor minimi digiti, it divides into two branches—a superficial

and a deep. The *superficial branch* breaks up into two digital branches. The smaller of the two communicates with the outer digital branch of the internal plantar nerve and supplies the flexor brevis minimi digiti and the plantar and dorsal interossei of the fourth space and the contiguous sides of the third and fourth and the fourth and fifth toes. The other, larger, digital branch supplies the outer side of the little toe. The *deep branch* accompanies the external plantar artery in the deep part of the sole of the foot, and supplies the three outer lumbrical muscles, the interosseous muscles in the three inner spaces, the transversus pedis, and the adductor hallucis muscles.

The **internal plantar nerve** is the larger of the two terminal divisions of the posterior tibial nerve. It accompanies the internal plantar artery along the inner side of the foot, running between the abductor hallucis and the flexor brevis digitorum. It gives cutaneous branches to the skin of the sole, muscular branches to the muscles beneath which it runs, and articular branches to the tarsal and metatarsal joints. Opposite the bases of the metatarsal bones it divides into four digital branches which pass between the primary divisions of the plantar fascia, accompanying the digital arteries. They are distributed in the following manner: The outer three digitals at the clefts of the toes divide, each into two branches for the supply of the adjacent sides of the third and fourth toes, the adjacent sides of the second and third toes, and the adjacent sides of the second and great toes; the innermost digital nerve passes along the inner side of the foot to supply the inner side of the great toe, and sends a branch to the flexor brevis hallucis muscle; the second digital nerve sends a filament to the first lumbrical muscle, the third digital gives off a filament to the second lumbrical muscle, and the fourth digital communicates with the external plantar nerve, with which it then supplies the adjacent surfaces of the third and fourth toes. All the digital nerves give off branches to the integument, to the matrix of the nail, and to the phalangeal joints. The internal plantar nerve supplies the same region in the sole of the foot that the median nerve does in the palm of the hand.

The second layer of muscles comprises the flexor accessorius digitorum pedis, the tendon of the flexor longus digitorum, to which the former is attached, the tendon of the flexor longus hallucis, and the lumbrical muscles.

The **flexor accessorius digitorum pedis** arises by two heads. The outer, tendinous, arises from the under surface of the os calcis and the long plantar ligament; the inner, large and muscular, arises from the inner or concave surface of the os calcis and from the calcaneo-scaphoid ligament. The two portions unite at an acute angle to form the belly of the muscle which is inserted into the outer side of the upper surface of the tendon of the flexor longus digitorum. The plantar surface of the flexor accessorius is in contact with the flexor brevis digi-



SECOND LAYER OF MUSCLES OF THE SOLE OF THE FOOT, PLANTAR VESSELS AND NERVES.

torum and with the external plantar vessels and nerve; the under surface is in relation with the os calcis and with the long calcaneo-cuboid ligament.

NERVE SUPPLY.—It receives its nerve supply from the external plantar.

ACTION.—Its action is to assist the flexor longus digitorum in bending the toes and to make the tendon of the flexor longus pull in a straight line toward the heel.

The **tendon of the flexor longus digitorum** enters the sole of the foot by passing over the internal lateral or deltoid ligament of the ankle-joint, and beneath the internal annular ligament. In the sole of the foot it passes over the tendon of the flexor longus hallucis, to which it is connected by a tendinous slip, beyond which it is joined by the flexor accessorius. It divides into four tendons, each of which enters the theca of the toe with the tendon of the flexor brevis digitorum, but dorsally to it. Opposite the middle of the proximal phalanges of the four outer toes the tendons pass through the slit-like openings in the tendons of the flexor brevis digitorum. They are inserted into the base of the last phalanges.

NERVE SUPPLY.—Nerve supply and relations have been given with the description of the muscle.

ACTION.—Its action is to bend the phalangeal joints, and, acting with the flexor brevis digitorum, to bend the metatarso-phalangeal joints.

The **lumbricales** are four small muscles placed between, and arising from, the tendons of the long flexor. Each arises by two heads from the adjacent sides of the tendons, with the exception of the most internal, which arises from the inner side of the tendon which goes to the second toe. Each muscle terminates in an aponeurosis which passes round the inner side of the proximal phalanges of the four toes, and is inserted into the expansion of the tendon of the extensor longus digitorum, and into the dorsal aspect of the base of the proximal phalanges of the corresponding toes.

NERVE SUPPLY.—The two inner lumbrical muscles are supplied by the internal plantar nerve, and the two outer by the external plantar.

ACTION.—The action of these muscles is to assist the flexors in bending the metatarso-phalangeal joints of the four outer toes, and, by their attachment to the tendons of the extensor longus digitorum, they assist that muscle in straightening the toes.

The **tendon of the flexor longus hallucis** enters the sole of the foot between the heads of the flexor brevis hallucis. It runs over the plantar surface of the latter, enters the digital sheath, and is inserted into the base of the last phalanx of the great toe.

NERVE SUPPLY.—The nerve supply has been given under the description of the muscle.

ACTION.—The action of this tendon is to bend the last phalanx of the great toe and to assist in extending the ankle.

DISSECTION.—To make a dissection of the remaining tissues in the sole of the foot, it will be necessary to cut the tendon of the flexor longus digitorum, the flexor accessorius, and the plantar vessels and nerves near the os calcis.

By displacing the severed structures downward, the third layer of muscles—the flexor brevis hallucis, the adductor hallucis, the flexor brevis minimi digiti, and the transversus pedis muscles—will be brought into view. The long plantar ligament, the sheath of the peroneus longus, and the interossei muscles will also be exposed.

The **flexor brevis hallucis** arises by a pointed tendon from the inner part of the under surface of the cuboid bone, from the external cuneiform bone, and from the prolongation of the tendon of the tibialis posticus. It passes along the metatarsal bone of the great toe to reach a point near the head of the bone. Here it divides into two portions which are inserted into the sides of the proximal phalanx of the great toe, the inner being associated with the abductor hallucis, and the outer with the tendon of the adductor hallucis. In each of these portions there is a sesamoid bone.

NERVE SUPPLY.—It receives its nerve supply from the internal plantar.

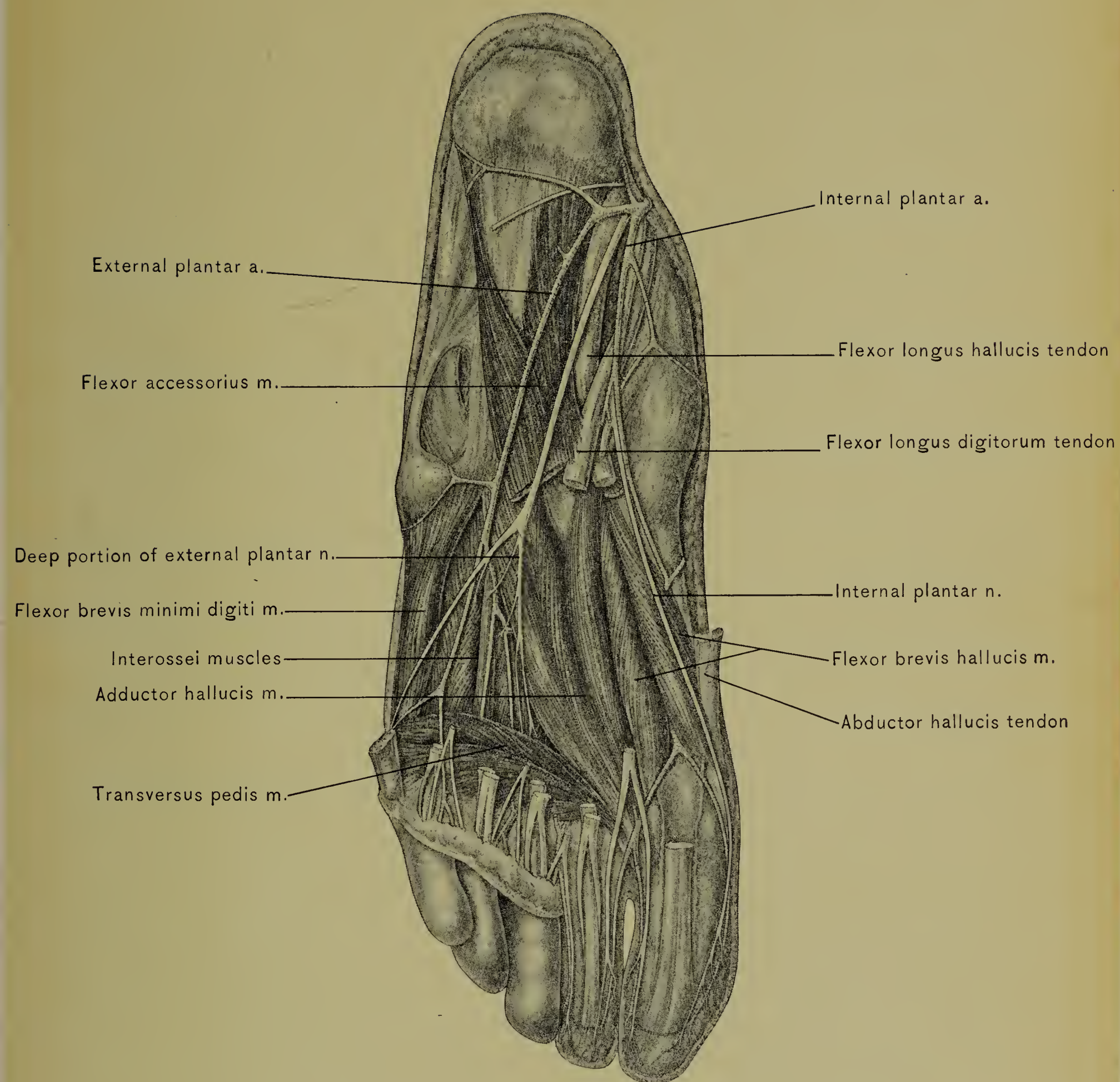
ACTION.—Its action is to flex the metatarso-phalangeal joint of the great toe. In very bad forms of talipes varus the tendon of insertion of this muscle will often call for division, as severing of the plantar fascia alone will not correct the deformity.

The **adductor hallucis** is a very strong muscle, larger than the preceding. It arises from the bases of the second, third, and fourth metatarsal bones and from the long plantar ligament, which forms the sheath of the peroneus longus. Its fibers pass forward and inward and terminate in a tendon which is inserted into the outer side of the base of the proximal phalanx of the great toe in connection with the outer head of the flexor brevis hallucis.

NERVE SUPPLY.—It receives its nerve supply from the external plantar nerve.

ACTION.—Its action is to draw the great toe toward the others and to assist in bending the metatarso-phalangeal joint of this toe.

The **flexor brevis minimi digiti**, a small muscle, is situated along the outer side of the foot. It arises from the base of the metatarsal bone of the little toe and from the sheath of the peroneus longus. Its fibers pass forward and terminate in a tendon which is inserted into the outer side of the base of the proximal phalanx of the little toe and the adjacent part of the fifth metatarsal bone.



THIRD LAYER OF MUSCLES OF THE SOLE OF THE FOOT.

NERVE SUPPLY.—It receives its nerve supply from the external plantar nerve.

ACTION.—Its action is to bend the metatarso-phalangeal joint of the little toe and to assist in adducting it.

The **transversus pedis** is a slender muscle which runs transversely over the heads of the metatarsal bones. It arises from the under surface of the head of the metatarsal bone of the little toe, and from the capsular ligaments of the metatarso-phalangeal articulations of the four outer toes. It is inserted into the outer side of the proximal phalanx of the great toe, in connection with the adductor hallucis.

NERVE SUPPLY.—Its nerve supply comes from the external plantar nerve.

ACTION.—Its action is to draw the great toe toward the second.

DISSECTION.—The flexor brevis hallucis and the adductor hallucis are to be severed at their origin and reflected, when will be brought into view the plantar arch and its branches, the communicating branch of the external plantar nerve, and the terminal part of the communicating branch of the dorsalis pedis artery, which enters the sole of the foot through the first interosseous space.

The Plantar Arch.—The formation of the plantar arch has already been given. It runs across the bases of the metatarsal bones resting upon the interossei muscles. It is covered by the flexor tendons, the lumbricales, the adductor hallucis, and a part of the flexor brevis hallucis. From the arch are given off the articular, posterior perforating, and four digital arteries for the supply of the three outer toes and the outer surface of the second toe. These have already been described.

The *deep branch of the external plantar nerve* accompanies the plantar arch and ends in the adductor hallucis muscle. It supplies the three inner interossei, the transversus pedis, the adductor hallucis, and the two external lumbrical muscles. This nerve corresponds to the deep branch of the ulnar nerve in the palm of the hand.

DISSECTION.—The digital vessels and nerves are to be displaced downward, when the interosseous muscles can be studied. The transversus pedis and the flexor brevis minimi digiti are to be reflected from their origin. The strong band of fibrous tissue connecting the heads of the metatarsal bones (the transverse metatarsal ligament) and the interossei muscles are now exposed. These muscles are covered with a thin layer of fascia attached to the transverse metatarsal ligaments; this is to be removed and the ligaments cut between the bones.

The interossei muscles constitute the fourth layer of muscles. They are seven in number, four dorsal and three plantar.

The **plantar interossei** are situated beneath the three outer metatarsal bones, from the under and inner surfaces of which they arise. They are inserted into the inner side of the bases of the proximal phalanges of the corresponding toes,

and partly by an expansion to the extensor tendons on the back of the phalanges. These muscles are smaller than the dorsal interossei.

The **dorsal interossei** are situated in the metatarsal spaces. They arise by two heads from the sides of the adjacent metatarsal bones and are inserted into the bases of the proximal phalanges, and into the aponeurosis of the extensor tendons upon the back of the toes. The first is inserted into the inner side of the second toe, and the remaining three into the outer sides of the second, third, and fourth toes. The first dorsal interosseous of the foot, like its homologue in the hand, has an artery passing between its two heads. In the foot the vessel is the communicating branch of the *dorsalis pedis*, while in the case of the hand the radial artery passes between the two heads of the first dorsal interosseous to form the greater part of the deep palmar arch.

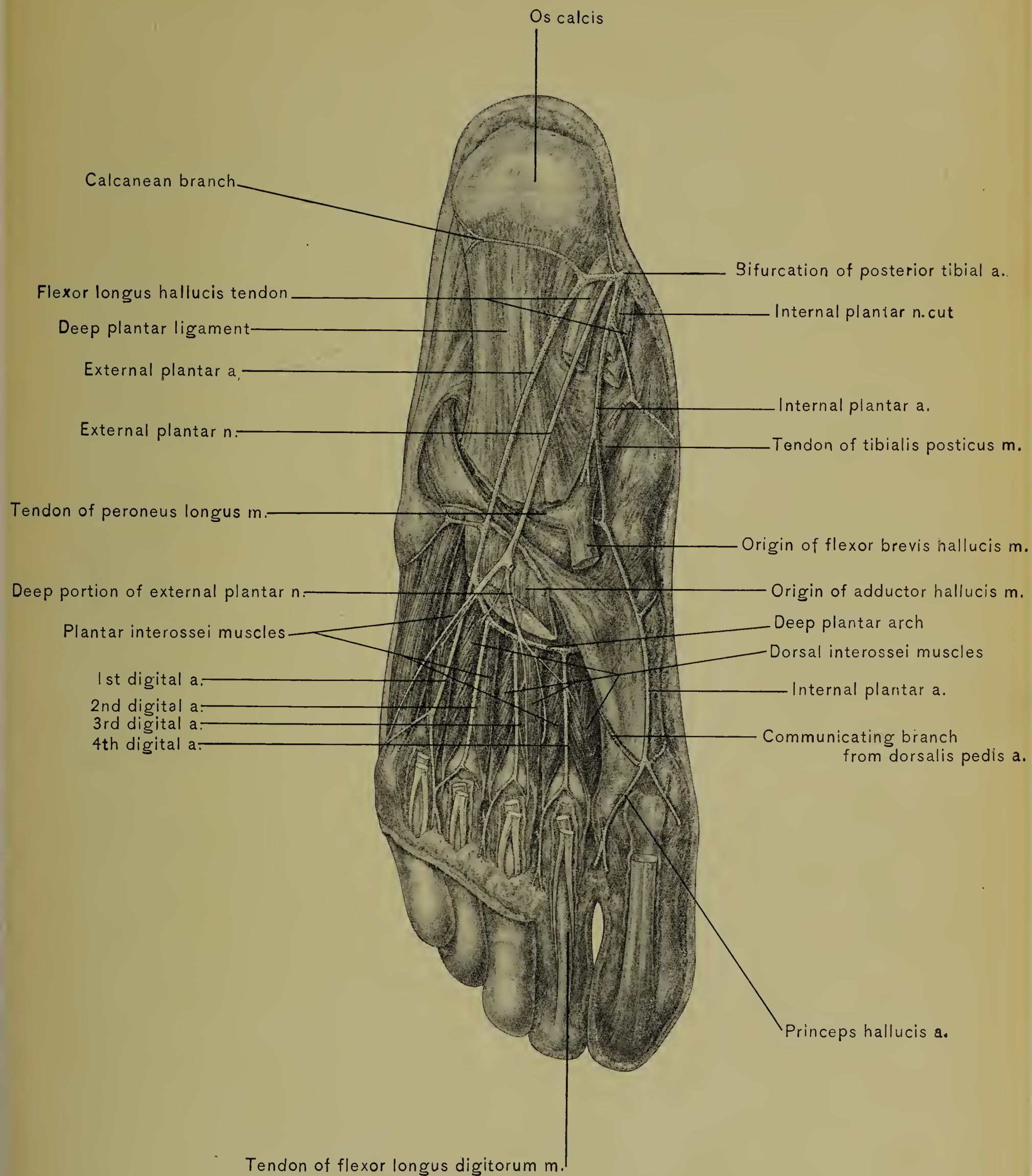
Between the tendons of the interossei at the heads of the metatarsal bones are bursæ which facilitate movement; these become enlarged at times and occasion painful swellings between the roots of the toes.

NERVE SUPPLY.—The interossei muscles are supplied by branches of the external plantar nerve.

ACTION.—The action of the interossei is to assist the flexor tendons in bending the metatarso-phalangeal joints, and the extensors in straightening the last two phalangeal joints. In this they are aided by the *lumbricales*. The dorsal interossei are abductors of the toes from an imaginary line drawn through the axis of the second toe, and the plantar interossei adductors to the same line.

The **tendon of the *tibialis posticus*** passes forward over the internal lateral ligament of the ankle-joint and over the capsular ligament of the astragalo-scaphoid articulation, at the latter point containing a sesamoid bone. It is inserted into the tuberosity of the scaphoid bone. From its insertion, prolongations are continued to all the tarsal bones except the astragalus, and to the bases of the metatarsal bones with the exception of the inner and outer. From the manner in which the tendon is inserted it must assist largely in the maintenance of the arch of the foot.

The **tendon of the *peroneus longus***, the deepest in the sole, is confined by a strong fibrous sheath which is lined throughout by a synovial membrane. The sheath is to be laid open, when the tendon will be seen to run through a groove on the under surface of the cuboid bone, then obliquely across the sole. It is inserted into the outer side of the base of the metatarsal bone of the great toe and into the internal cuneiform bone; sometimes it has a slip of attachment to the base of the second metatarsal bone.



FOURTH LAYER OF MUSCLES OF THE SOLE OF THE FOOT, PLANTAR ARCH, AND DEEP BRANCH OF THE EXTERNAL PLANTAR NERVE.

JOINTS OF THE LOWER EXTREMITY.

THE HIP-JOINT.

The **Hip-joint** is formed by the reception of the head of the femur into the acetabulum of the innominate bone. The articulating surfaces of both bones are covered with cartilage; the cartilage of the femur covers the entire head of the bone, with the exception of a small place at the center, where the ligamentum teres is attached, while that of the acetabulum is absent at the cotyloid notch, thus giving the cartilage a horseshoe shape. The covering of the head of the femur is thicker at the center, where it bears the greatest amount of strain, than at the circumference; that of the acetabulum is thicker above than below.

The ligaments of the hip-joint are the capsular, the cotyloid, the transverse, and the ligamentum teres.

The **capsular ligament** is a dense and strong capsule which is attached to the margin of the acetabulum, or cotyloid cavity, above, and to the neck of the femur below. It is attached at the upper and posterior part of the cotyloid cavity to the bone close to the cotyloid ligament; in front, it is connected with the cotyloid ligament; below, at the notch, it is attached to the transverse ligament and, by a few fibers, to the margin of the obturator foramen. Its attachment to the neck of the femur varies in different parts; behind, it is attached to the posterior part of the neck at its middle; above, to the base; and in front, to the intertrochanteric ridge (spiral ridge). The capsule is much thicker and stronger over the anterior and external parts of the joint, where the greatest amount of resistance is required, than below and posteriorly, where it is thin, loose, and of a greater length. It is composed of circular and longitudinal fibers. The circular fibers are most abundant at the posterior and lower parts of the capsule, and near the middle of the lower wall form a thick band known as the *zona orbicularis* of Henle. The longitudinal fibers are most abundant at the anterior and upper part, where they form accessory ligaments which tend to strengthen the capsule where the most strain is exerted. These accessory ligaments are the ilio-femoral, the pubo-femoral, and the ischio-capsular. The *ilio-femoral band* is placed in front of the joint and constitutes the thickest and most powerful part of the capsule. It is attached above to the anterior inferior spine of the ilium and passes downward in front of the joint. In its downward course, it splits into two divisions which gradually diverge, thus giving the ligament an inverted Y appearance. The outer limb of the Y is attached to the anterior intertrochanteric line, close to the great trochanter, and the inner limb to the lower end of the same line. The *pubo-femoral band* consists of several fasciculi which pass from the ilio-pectineal eminence to the front

of the capsule. The fibers of this ligament often blend with those of the ilio-femoral ligament. The *ischio-capsular band* arises from the ischium below the acetabulum and along the lower margin of the groove for the obturator externus muscle. It passes to the lower anterior part of the capsule, where it blends with the band of circular fibers.

The **cotyloid ligament** is a fibro-cartilaginous band that is attached to the margin of the acetabulum within the capsule. It tends to deepen the cotyloid cavity and to protect its edges and the head of the femur from injury due to sudden or extreme pressure. At the lower part of the acetabulum it blends with the transverse ligament, and thus a complete circle is formed. On transverse section the ligament is prismoidal in shape, being much thicker at its attachment to the margin of the cotyloid cavity than at its free margin. Its two surfaces are lined with a synovial membrane, that of the outer surface being in contact with the capsule, while the inner is inclined inward in order to lessen the cotyloid cavity and to become attached to the fibro-cartilage covering the head of the femur. The cotyloid ligament is composed of dense, strong fibers which arise from the rim of the acetabulum and then interlace at acute angles. It is stronger above and behind than below and in front.

The **transverse ligament** is practically a portion of the cotyloid ligament, as it is so closely blended with the latter that their fibers cannot be separated. It consists of broad, flat bands which stretch across the cotyloid notch, thus converting it into a foramen for the passage of the vessels to the joint.

The **ligamentum teres** is a band about one and a half inches (3.75 centimeters) long which extends from the cotyloid notch to the head of the femur, thus being entirely interarticular. The pelvic end of the ligament is attached to the rough surfaces on either side of the cotyloid notch, and to the transverse ligament; the femoral end is attached to the rough depression just below the center of the head of the bone and to the fibro-cartilage investing this portion of the femur. The ligament is entirely enveloped by synovial membrane, and conveys an artery to the head of the femur. It is often absent, and plays but an unimportant rôle in the mechanism of the hip-joint.

The *synovial membrane of the hip-joint* lines the capsule and covers the cotyloid ligament and the ligamentum teres, being reflected from these upon the intra-capsular bone surfaces as far as the edges of the articular cartilage. At the bottom of the acetabulum it passes over some vessels and fat upon the ligamentum teres at the head of the bone, and in doing so covers the fat in the rough hollow at the bottom of the cotyloid cavity.

RELATIONS.—The relations of the hip-joint are, in front, the iliacus and psoas magnus muscles, with an intervening bursa; above, the short head of the

Band stretching between attachments of rectus femoris and vastus externus muscles

Weak spot in the capsule, sometimes perforated, allowing the hip joint to communicate with the bursa under the psoas m.

Ilio-femoral band

Pectineo-femoral band

Cotyloid cartilage

Capsular ligament

Ligamentum teres

Transverse ligament

Retinacula or reflected fibres of capsular ligament

ANTERIOR VIEW AND LONGITUDINAL SECTION OF THE HIP-JOINT.

rectus femoris and the closely adherent gluteus minimus; internally, the pectineus and obturator externus; behind it are the short external rotators, the piriformis, the obturator internus and the two gemelli, the obturator externus and the quadratus femoris.

BLOOD SUPPLY.—It is supplied by the obturator and internal circumflex below, the gluteal above, and the sciatic arteries behind.

NERVE SUPPLY.—It receives articular branches from the sacral plexus, great sciatic, obturator, and accessory obturator nerves.

MOVEMENTS.—The hip-joint is a ball-and-socket joint, and is capable of very free motion, but not as much as the shoulder-joint, though, like it, it abducts, adducts, anteducts (flexes), retroducts (extends), circumducts, and rotates. The thickened anterior capsule and the ilio-femoral ligament limit extension, and are aided in this by the ilio-psoas and pectineus muscles. Flexion is free, its only limit being contact between the neck of the femur and the margin of the acetabulum. Abduction is limited by the pubo-femoral bands of Henle and the lower part of the capsule, and adduction is checked by the ischio-capsular fibers and the top of the capsule. Combined flexion and adduction stretch the ligamentum teres, which thus resists dislocations upon the dorsum of the iliac bones. The shortness and strength of the anterior capsule, by preventing overextension, assist materially in the maintenance of the erect attitude while walking and standing.

The **femoral artery** passes directly over the head of the bone, but is separated from it by the ilio-psoas muscle, where it is readily compressed, the vein being close upon its outer side, and the anterior crural nerve separated by about a half inch (1.25 centimeters) from its outer side. The great sciatic nerve and vessels are separated from the joint by the short outward rotators.

In **synovitis of the hip** with considerable effusion the capsule becomes sufficiently distended at times to push forward in Scarpa's triangle, causing bulging of the structures composing the floor, and carrying the femoral artery close against the skin, where it is readily seen pulsating. Behind, it may obliterate the gluteal fold. The tension in the joint, increased by the action of the muscles that cross it, limits movements of the hip. Flexion, adduction, and inward rotation is the favorite attitude of the thigh in hip-joint hydrarthrosis, and this is probably due, as was suggested by Hilton, to the maximum laxity of the capsule secured by this position. The earliest pain felt in hip-joint disease is upon the inner side of the thigh or knee, or in the popliteal space, along the terminal distribution of the obturator nerve, and is supposed to be a reference of irritation of the hip-joint articular fibers of this nerve to the wrong area of distribution. It is analogous to the pain felt in the

glans penis from the vesical irritation of stone in the bladder, or to earaches due to dental nerve irritation from decayed teeth.

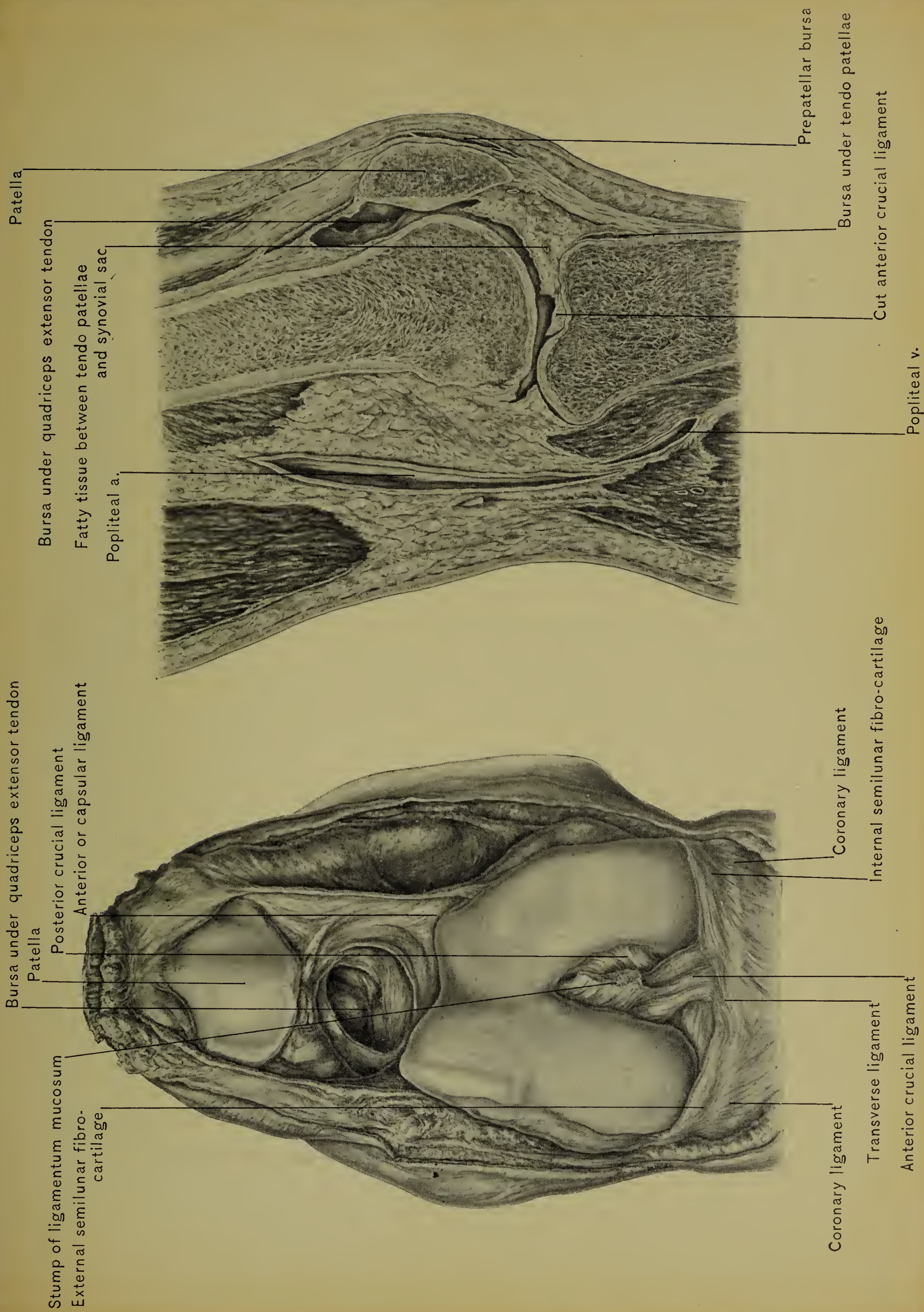
Abscess of the hip-joint opens behind through the thinnest part of the capsule. Hence it may burrow in various directions between muscles and fascial septa. It may perforate the acetabulum to gain access to the pelvis, eventually to form an ischio-rectal abscess which may open either upon the perineum or into the rectum. It may also perforate the anterior portion of the capsular ligament in the fork of the femoral (Y) ligament, and enter the bursa between the joint and the ilio-psoas muscle, thence extending upward to form a pelvic abscess, and, perhaps, resulting in caries.

THE KNEE-JOINT.

The **Knee-joint**, the largest in the body, is formed by the articulation of the tibia, femur, and patella. It is a ginglymoid or hinge joint, although there is a slight rotary motion round a vertical axis. In some respects it is the weakest joint in the body, as the bony surfaces forming it are never in complete contact. The true strength of the articulation depends upon the number, size, and arrangement of its ligaments, together with the strong muscles and expansions of fascia which pass over the joint. If the articulating surfaces be analyzed, the joint would be found to consist of three separate articulations, each condyle of the femur articulating separately with the corresponding tuberosity of the tibia and the patella with the femur. These articulations have a common synovial membrane.

The ligaments of the knee-joint are divided into an external or superficial, and an internal or deep set; the former including the fibrous expansion of the quadriceps extensor tendon, the ligamentum patellæ, the posterior ligament, the external lateral, internal lateral, and capsular; and the latter or internal group including the anterior crucial, the posterior crucial, the internal and external semilunar fibro-cartilages, the coronary, the transverse, and folds of the synovial membrane known as the ligamentum mucosa and ligamenta alaria.

The **fibrous expansion of the extensor tendons** consists of three portions—an anterior and two lateral. The *anterior portion* is inserted into the upper portion of the patella, some of its superficial fibers passing over the bone to blend with the ligamentum patellæ. The *lateral portions* are attached to the sides of the patella, and to the anterior aspect on either side of the central portion; some of the fibers extend to the oblique lines running from the tubercle of the tibia to the tuberosities. Internally the fibers blend with the periosteum of the tibia, and externally with the ilio-tibial band. In this manner an anterior cap is formed



ANTERIOR VIEW AND LONGITUDINAL SECTION OF THE KNEE-JOINT.

which adds greatly to the strength of the joint; it is separated from the synovial membrane by a layer of fatty tissue.

The **ligamentum patellæ**, or **anterior ligament**, or **tendo patellæ**, consists of that portion of the quadriceps extensor tendon between the lower end of the patella and the tibia. It is a powerful, broad, flat tendon, about three inches (7.5 centimeters) long, extending from the lower end of the patella to the bottom of the tubercle upon the front of the upper end of the tibia. A small bursa exists between the lower end of the back of this tendinous ligament and the top of the tibia above the tubercle into which it is inserted, and another exists between the patella and skin. The ligament is separated from the knee-joint between the patella and tibia by a cushion of fat; its sides are connected with the vasti aponeurosis.

The **internal lateral ligament** is a broad band which is situated on the posterior aspect of the inner side of the knee. It is thickest in its posterior part. It extends from the inner tuberosity of the femur to the inner tuberosity and posterior border of the tibia, and several inches down the shaft. Its joint surface rests against the articular synovial membrane above, at its middle it is intimately united to the semilunar fibro-cartilage, and below it is separated from the bone by the anterior slip of the insertion of the semimembranosus muscle.

The **posterior ligament** (ligament of Winslow) is a dense fibrous mass connecting the adjoining ends of the femur and tibia behind. It is composed essentially of two parts, superficial and deep. The *superficial portion* is a thick, heavy fibrous band passing obliquely upward and outward from the insertion of the semimembranosus along the posterior surface of the inner tuberosity of the tibia to the outer condyle under and alongside the origin of the outer head of the gastrocnemius. It is virtually an extension of the semimembranosus tendon reinforced above by the outer head of the gastrocnemius. The *deep portion* consists of vertical fibers that pass upward from the back of the tibia below to unite with the oblique superficial band, and of vertical and oblique fibers coming down the back of the inner condyle and intercondyloid notch above, the oblique fibers passing downward and outward, and being partly derived from the inner head of the gastrocnemius. This is the strongest, densest, and tightest ligament of the joint, preventing hyperextension of the knee and guarding against posterior swellings from joint effusion, where such tumefaction might cause serious complications by compression of the popliteal vessels and nerves, as it forms part of the floor of the popliteal space and has resting directly upon it the popliteal artery. This ligament is pierced by the azygos articular artery, a branch of the popliteal.

Two external lateral ligaments guard this joint upon its outer side—a posterior short, and an anterior long ligament. The *posterior* or *short external*

lateral ligament extends from the back of the outer side of the external condyle, where it is blended with the upper end of the oblique fasciculus of the posterior ligament under the outer head of the gastrocnemius, to the tip of the styloid process of the fibula. Beneath and adherent to it is the tendon of the popliteus muscle; it is also intimately adherent to the capsule of the joint. The *anterior* or *long external lateral ligament* extends from the external tuberosity of the femur to the head of the fibula. This ligament is intimately adherent to the capsule; the tendon of the popliteus muscle and the external articular vessels pass between it and the joint, while externally it is crossed by the biceps tendon, which is sometimes divided by this ligament previous to its insertion.

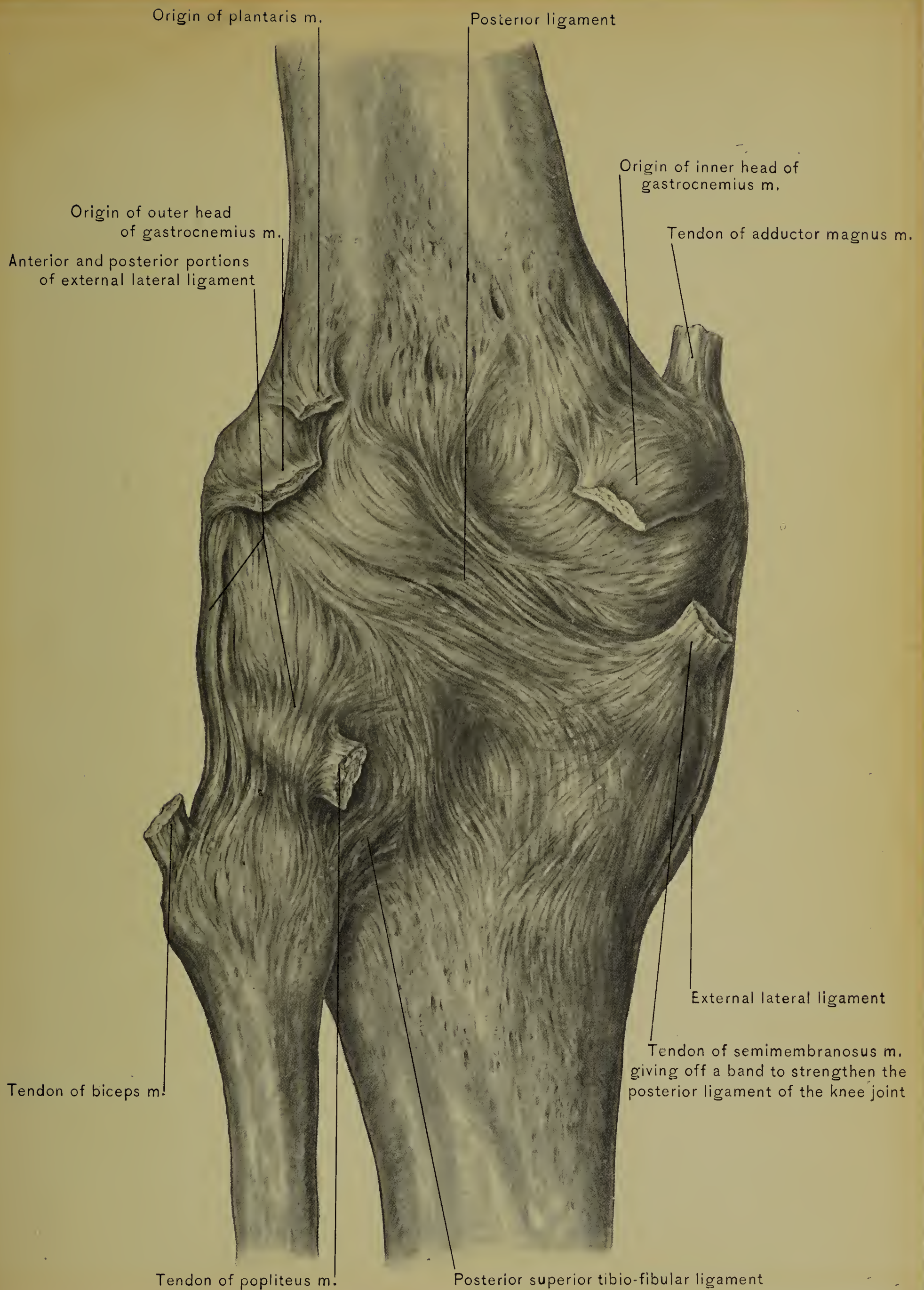
The **capsular ligament** is a very thin, but strong and loose fibrous pouch filling the intervals between the preceding ligaments. It is attached to the osseous margins of the joint surfaces of the femur, tibia, and patella, and joins the margins of the external ligaments. Upon each side of the patella, under the vasti muscles, where it crosses from the tibia to the patella, it has been called the **lateral patellar ligament**.

If care has been taken during the preceding dissection not to enter the joint cavity, a hole should be bored with a gimlet through the patella, into which a blow-pipe should be introduced and the joint fully distended with air. The extent of the synovial sac can thus be effectively demonstrated, as was the custom of the late Professor Corydon L. Ford. The upper attachments of the patella should then be divided and the bone turned down, when the study of the internal ligaments may be begun.

As the patella is pulled downward, three folds of the synovial membrane will be observed: one, extending from the front of the joint below the patella to the front of the intercondyloid notch, called the **ligamentum mucosum**; and two fringe-like folds extending up and out from its sides to the lateral edges of the patella, called the **ligamenta alaria**. These and the lateral attachments of the patellar tendon may be severed, the tendon turned down, and the bursa between it and the tibia exposed. Flexion of the joint will now expose, from the front, the two crucial ligaments, an anterior and a posterior.

The **anterior** or **external crucial ligament**, the smaller, extends from a depression in front of the tibial spine, where it is blended with the front end of the outer semilunar fibro-cartilage, to the back part of the inner side of the external condyle, its direction being upward, backward, and outward.

The **posterior** or **internal crucial ligament**, the larger, and less oblique than its fellow, is attached to a depression behind the tibial spine, blending there with the posterior extremity of the external semilunar fibro-cartilage, whence it passes upward, forward, and inward to the front of the inner side of the external condyle.



POSTERIOR VIEW OF THE KNEE-JOINT.

A small fibrous fasciculus connects the two ligaments where they cross. The relative positions of these ligaments are readily remembered by a simple rule of Professor Ford—namely, that they occupy the same relative position as a pair of crossed legs, which arrangement always represents the position of the ligaments of the anterior knee.

The **semilunar cartilages** are two crescentic fibro-cartilages that lie upon the tops of the two tibial tuberosities, deepening the joint surface; the outer margin is thick, the inner concave edge thin and sharp; the upper surface is concave for the femoral condyle, and the inferior flat to rest upon the top of the tibia. The *internal semilunar fibro-cartilage* is almost semilunar; it is attached in front to the inner side of the articular surface of the external tibial tuberosity, and behind to the inner side of the depression behind the tibial spine, where it blends with the posterior crucial ligament. Its edge is united to the internal lateral ligament and head of the tibia by the coronary ligaments. The *external semilunar fibro-cartilage*, almost circular, is attached by its anterior and posterior extremities to the front and back of the base of the tibial spine respectively. Its circumference is held to the tibial head by the coronary ligaments, and its outer border is grooved for the lodgment of the popliteus tendon, which separates it from the capsule. From its anterior edge it gives off the transverse ligament, and its anterior extremity blends with the anterior crucial ligament. Its posterior extremity has three divisions, one blending with the back of the anterior crucial ligament, the other two passing upward and forward to be inserted in the outer side of the inner tibial tuberosity in front of and behind the attachment of the posterior crucial ligament. It forms the *accessory band of the posterior crucial ligament*.

The **transverse ligament** is a fibrous continuation from the anterior convex margin of the external semilunar fibro-cartilage to the like part of its fellow; it varies much in size, and is often absent.

The **coronary ligaments** are short, straight, fibrous bands connecting the convex margins of the semilunar fibro-cartilages with the adjoining tibial bone and ligaments.

The *synovial membrane of the knee-joint*, the largest in the body, lines the interarticular surfaces not subject to compression; *i. e.*, all the surfaces except those covered by articular cartilage, except the upper and lower surfaces of the semilunar fibro-cartilages, which are covered by this membrane. It extends upward under the quadriceps extensor a distance of several inches, extends laterally from the patella under the vasti muscles, especially under the internus, and is separated from the patellar ligament by a cushion of fat. Its reflections from the patella, forming the alar and mucous ligaments, have been described. The supra-patellar pouch of this membrane is drawn up in knee

extension by the subcrureus muscle attached to its top. The knee-joint is subcutaneous in front and upon either side, but behind, where it forms the floor of the popliteal space, it is closely related with many important structures. The popliteal vessels and internal popliteal nerve pass downward behind it in the middle of the space, between the two heads of the gastrocnemius, the nerves being most superficial, and the artery hugging the bone and ligament, with the vein between both; external to them are the semitendinosus, semimembranosus, and biceps muscles, and the external popliteal nerve, while upon their inner side are the gracilis and sartorius muscles, the internal saphenous nerve, the superficial portion of the anastomotica magna artery, and the long saphenous vein, the popliteus tendon being really within the joint at this point encased in its enveloping synovial sheath.

BLOOD SUPPLY.—The knee-joint is supplied with blood by branches of the femoral anastomotica magna, popliteal articular, and anterior tibial recurrent arteries.

NERVE SUPPLY.—The nerve supply is derived from branches of the obturator, anterior crural, and outer and inner popliteal nerves.

MOVEMENTS.—The movements of the knee-joint are flexion, extension, and rotation, the last being most readily demonstrated upon the live body with the knee at right angles and the foot upon the floor. Rotation is around the axis of the tibia. During flexion and extension the relatively short articular surfaces of the tibia glide over the more extensive ones of the femoral condyles, changing their relations. Thus, in extreme extension the middle of the condylar surfaces are upon the anterior tibial surface and edge; in middle flexion the lower condylar surface rests upon the middle of the tibial surface; and in extreme flexion the back of the condylar surface rests upon the back part of the tibial surface and its posterior edge. This action is identical with that of the phalangeal and knuckle joints. The ligamentum patellæ, being non-elastic, pulls the patella downward over the femoral condyles during flexion, so that when it is complete this bone lies over the intercondyloid notch. All the ligaments of the joint are relaxed during extreme flexion except that of the patella, and during the process of flexion, before it is tense, rotation of the leg at the knee is possible. Flexion is only checked by leg and thigh contact. In extreme extension the patellar ligament is so relaxed as to permit its free movement from side to side, but the other true ligaments are tense. Overextension is prevented by the posterior crucial and posterior common ligaments. The anterior crucial ligament checks inward rotation (pronation), which is mainly accomplished by the popliteus. The posterior crucial ligament checks outward rotation (supination), which is mainly accomplished

by the biceps. The crucial ligaments hold the tibia and fibula together, and check forward, backward, or lateral displacements. The semilunar fibrocartilages adapt the top of the tibia to the femoral condyles, and protect the surfaces of both bones from injury due to violent and severe impact.

In most mammals the patellar-condylar and the two tibio-condylar articulations form distinct joints with separate synovial sacs, which, however, sometimes communicate. This division is rudimentarily made in man by the ligamentum mucosum, while the crucials are interarticular lateral ligaments. The patella performs a gliding and coaptating function, the former being self-evident and the latter shown by a vertical double row of three facets upon the posterior patellar surface, and a single facet below the last facet of the inner row. During extension the lower facets touch the surface of the condyles of the femur; in semiflexion the middle facets, and in fuller flexion the upper facets, lie upon the femoral surface; whilst in extreme flexion the patella, having been everted by the more prominent inner condyle, rests upon the outer edge of this condyle by its lowest inner facet.

Care must be exercised in complaints of the knee-joint not to mistake the cushion of fat behind the patellar tendon for a serous or purulent accumulation of fluid, as it may readily be mistaken for either. Effusions into the joint raise the patella from the condyles and cause slight genuflexion, whereas effusions into the pre-patellar bursa obscure the bone, and the fluctuation is subcutaneous. In distention of the knee-joint with fluid, bulging exists upon each side of the ligamentum patellæ and patella, and under the quadriceps. By compressing any of these bulges, the others are exaggerated; and by this means the patella may be rocked upon the imprisoned fluid.

Pain in the knee may indicate early **hip-joint disease**, as well as affections of any of its supplying nerves anywhere between their distribution and central origin.

The **bursæ** near the knee-joint are numerous. The bursa between the patellar tendon and tibia, and the pre-patellar bursa, have been described. A small one exists between the skin and tibial tubercle. A bursa is found under each gastrocnemius head, the inner often opening into the knee-joint and also into another bursa between the head of the tibia and the semimembranosus muscle. This bursa is sometimes distended with synovial fluid, being made hard, tense, painful, and distinctly outlined by extension, but being much less evident during flexion. Sometimes fluctuation can be demonstrated between its contents and that of the knee-joint. If it is carelessly opened without regard to its communication with the knee-joint, irreparable damage may be done by an acute septic arthritis. Other bursæ also exist between the lateral ligaments and the tendons that cross them. There is also a subcrureus bursa between the subcrureus muscle and

the femur, which in the adult communicates with the synovial pouch of the knee-joint. Communication sometimes occurs between the knee-joint and the upper tibio-fibular membrane, through the bursa beneath the popliteal tendon.

THE TIBIO-FIBULAR JOINTS.

The **Tibio-fibular Joints** are situated at the two extremities of the tibia and fibula, and are called *superior* and *inferior*. The *interosseous membrane* connects the two bones along their shafts.

The **superior tibio-fibular joint** consists of the juncture of the upper inner surface of the head of the fibula with the under surface of the outer tuberosity of the tibia, each a flat oval surface. These surfaces are held together by the capsular and the anterior and posterior tibio-fibular and the superior interosseous ligaments.

The *capsular ligament* is attached close to the articular margins of the fibula and tibia. The capsule and the coronary ligament of the knee separate it from the knee-joint in front; but behind, where it is thin, it may communicate with the bursa under the popliteus tendon.

The *anterior tibio-fibular ligament* consists of flat bands (two or three) extending across the upper part of the anterior juncture of the bones, extending upward and inward from the fibular head to the tibial tuberosity, beneath the anterior portion of the biceps tendon.

The *posterior tibio-fibular ligament*, thick and broad, extends from the back of the fibular head of the external tibial tuberosity, and is covered by the popliteus tendon.

The *superior interosseous ligament* binds the bones together for three-fourths of an inch (1.9 centimeters) below their articulation, and is continuous below with the interosseous membrane.

The *biceps tendon* also acts as a ligament to the tibio-fibular joint.

The *synovial membrane* lining this joint is sometimes continuous with that of the knee in its upper back part.

The *interosseous membrane* is a fibrous sheet extending across the space between the two leg bones and is attached to their opposed ridges. Its fibers are directed downward and outward, a few only taking the other direction. It separates the front from the back of the leg, and gives attachment to the anterior tibial and the deep posterior tibial muscles. It is widest above, where it contains an oval foramen for the transmission of the anterior tibial vessels; a smaller aperture at its lower end gives passage to the anterior peroneal vessels. It is continuous above and below with the superior and inferior interosseous ligaments.

The **inferior tibio-fibular joint** is formed by the union of the rough convex inner surface of the lower end of the fibula with a similar surface upon the outer side of the lower end of the tibia. These surfaces are held together by the following four ligaments.

The *inferior interosseous ligament* is composed of numerous strong short fasciculi extending between the adjacent rough surfaces of these bones, forming their main bond of union, and being continuous with the interosseous membrane above.

The *anterior tibio-fibular ligament*, triangular, with the base below, passes down and out from the outer margin of the tibia to that of the fibula, the upper fibers being the shortest. In front it is crossed by the peroneus tertius muscle (when present) and the deep fascia of the leg.

The *posterior tibio-fibular ligament* has attachments behind similar to the preceding, but smaller.

The *transverse ligament*, long and narrow, and continuous with the posterior ligament, is placed transversely behind the joint from the external malleolus to the back of the tibia near its malleolus. By a downward projection beyond these bones, it becomes part of the articulating surface for the astragalus.

The *synovial membrane of the joint* is continuous with that of the ankle-joint.

BLOOD SUPPLY.—The blood supply of the upper tibio-fibular joint is derived from the lower articular branches of the popliteal artery, and from the anterior tibial recurrent artery. That of the lower joint is derived from the peroneal, anterior peroneal, anterior tibial, and external malleolar arteries.

NERVE SUPPLY.—The upper tibio-fibular joint is supplied by the external inferior articular and the recurrent branch of the external popliteal. The lower joint is supplied by the internal saphenous, posterior tibial, and anterior tibial nerves.

MOVEMENTS.—The movements of the tibio-fibular joints are insignificant, consisting only of the slightest gliding.

THE ANKLE-JOINT.

The **Ankle-joint** is formed by the articulation of the lower ends of the tibia and fibula with the top of the astragalus. The lower end of the tibia and the outer side of its malleolus, together with the inner side of the outer malleolus (fibula), form an angular arch that fits upon the upper surface of the astragalus. These bones are held in place by the following ligaments: the anterior, or tibio-tarsal, the posterior, and the two lateral.

The **anterior or tibio-tarsal ligament**, broad and thin, is attached, above, to

the articular edge of the tibia; and, below, to the astragalus in front of its joint surface. It is crossed in front by the tendons of the digital extensors, tibialis anticus, and peroneus tertius, and by the anterior tibial vessels and nerve; behind it is the synovial membrane.

The **internal lateral** or **deltoid ligament** is divided into a superficial and a deep layer. The *superficial layer*, strong, flat, and wider below than above, extends from the margin of the lower half of the internal malleolus, above, to the scaphoid bone and calcaneo-scaphoid ligament, below, by its anterior fibers; to the os calcis (*sustentaculum tali*) by its vertical, middle fibers; and to the inner side of the astragalus by its posterior fibers which pass downward and backward. The *deeper layer* is a strong band between the tip of the malleolus and the inner side of the astragalus under the margin of the joint surface. This ligament is crossed by the tendons of the tibialis posticus and the flexor longus digitorum muscles.

The **external lateral ligament**, owing to the fact that it consists of three distinct fasciculi, each of which takes a separate course, is described by some anatomists as three separate ligaments. The divisions of the ligament are generally classified as anterior, middle, and posterior fasciculi. The *anterior fasciculus* is the shortest of the three; it extends from the anterior margin of the tip of the fibula to the astragalus, anterior to its articular surface. Its direction is almost horizontally forward and inward. The *middle fasciculus* is cord-like and long; it extends from the apex of the external malleolus to the external surface of the os calcis. Its direction is obliquely downward and slightly backward. The *posterior fasciculus* is the most deeply seated of the three; its fibers extend from the depression in the posterior part of the astragalus. Its direction is horizontally outward.

A semblance of a *posterior ligament* is supplied by the transverse ligament at the back of the tibio-fibular junction.

The *synovial membrane of the ankle-joint* lines the adjacent surfaces of the ligaments and extends upward into the inferior tibio-fibular articulation.

The joint is crossed in front, from without inward, by the tendons of the peroneus tertius and extensor communis digitorum muscles, the anterior tibial nerve, the anterior tibial vessels, and the tendons of the extensor proprius hallucis and tibialis anticus muscles, with the annular ligament in front of all. Behind the inner malleolus, the joint is crossed, from without inward, by the tendons of the tibialis posticus and flexor longus digitorum, the posterior tibial vessels, the posterior tibial nerve, and the tendon of the flexor longus hallucis. These structures are held in place by the **internal annular ligament**, formed by the blending of the two layers of the deep fascia of the back of the leg; it extends from the inner malleolus to the adjacent surface of the os calcis. Behind the outer malle-

olus, the joint is crossed by the tendons of the long and short peronei, the latter being the more anterior. These tendons are held in place by the **external annular ligament**, which extends from the tip of the outer malleolus to the os calcis.

BLOOD SUPPLY.—The ankle-joint is supplied by the malleolar branches of the anterior and posterior tibial, and peroneal arteries.

NERVE SUPPLY.—It is supplied with nerves by branches of the anterior and posterior tibial, and internal saphenous nerves.

MOVEMENTS.—The movements of the ankle-joint consist in flexion and extension, with the possibility of slight lateral motion during extreme extension. This is because the front of the joint is wider than its back part, the astragalus being the same. When, therefore, the ankle is fully extended (the tarsus being in line with the front of the leg), the narrower back part of the top of the astragalus comes forward between the wider front portion of the intermalleolar space, thus permitting slight lateral movement. When, however, the opposite position exists, the intermalleolar ligaments are stretched by the forcing back of the widest surface of the astragalus toward the narrower part of the intermalleolar space. The outer margin of the upper joint surface of the astragalus is curved and longer than its inner edge, thus accounting for the slight inward movement of the toes when the foot is being extended.

The tendo Achillis is behind the ankle-joint, from which it is separated by loose connective tissue often containing an abundance of fat. This powerful structure really performs the retentive function of a posterior ligament to the joint, and its presence accounts for the absence, except in a most rudimentary form, of the posterior fibrous layer. This tendon requires section in contraction of the calf muscles causing club-foot (*talipes equinus*), or in fractures of the bones of the leg, that are otherwise impossible to adjust because of muscular contracture, and after osteotomy of a bowed leg. Tenotomy is best performed here by first making the tendon tense by strong ankle flexion, pushing the tenotome through the skin under the tendon and cutting from within outward (before backward). By cutting in the other direction, from without inward, the post-malleolar arteries might be wounded or some of the tendon sheaths be opened. Rupture of the tendon may occur from violent strain, the injured person feeling at the time as if struck violently above the heel. In cases of rupture of the tendo Achillis, the foot must be strongly extended and thus held until union be effected, or the torn ends may be approximated by sutures. In *talipes calcaneus* due to paralysis of the calf muscles, a part of the tendon is removed and the cut ends united, so that the heel may be held up mechanically against the flexing efforts of the anterior tibial muscles.

The muscles brought into play during the extension of the foot on the leg are

the gastrocnemius, plantaris, soleus, tibialis posticus, peroneus longus and brevis, flexor longus digitorum, and flexor longus hallucis; during flexion, the tibialis anticus, peroneus tertius, extensor longus digitorum, and extensor proprius hallucis; during adduction, the tibialis anticus and posticus; during abduction, the peronei.

Articulation effusion causes bulging in front of the joint (obliterating the tendinous markings), around the malleoli, and upon either side of the tendo Achillis. Extra-articular effusions are limited in area.

THE TARSAL ARTICULATIONS.

These articulations can be divided into the following groups: the calcaneo-astragaloid joint; the articulations of the anterior portion of the tarsus; and the medio-tarsal joint.

The Calcaneo-astragaloid Articulation.—The astragalus articulates with the os calcis at two points, making a posterior and an anterior articulation.

The **anterior calcaneo-astragaloid articulation** communicates with the medio-tarsal joints, and is formed by the upper anterior facet on the os calcis and the facets on the inferior surface of the head and neck of the astragalus. The ligaments of this point of union are the interosseous, the internal or anterior calcaneo-astragaloid, and the external calcaneo-scaphoid.

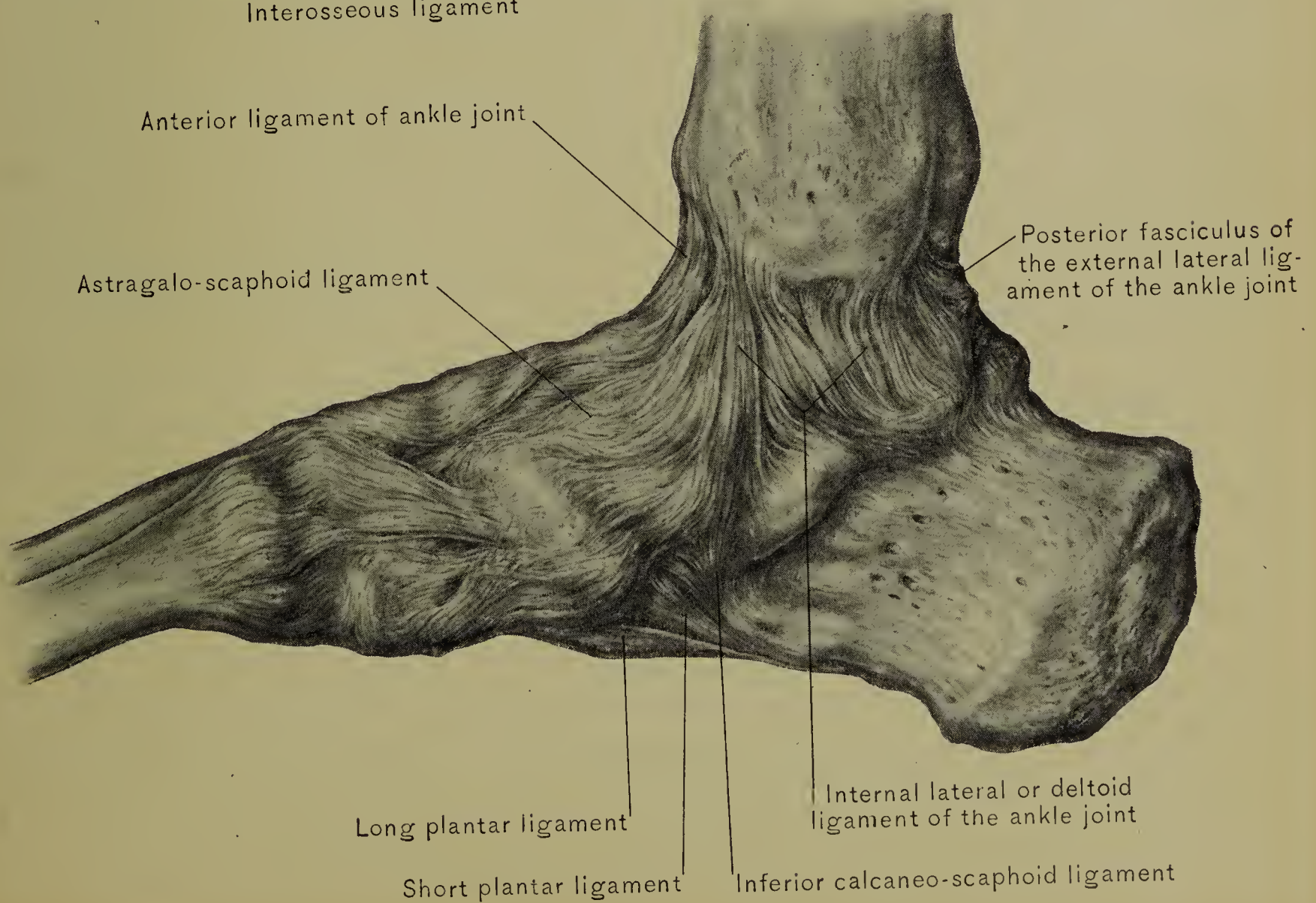
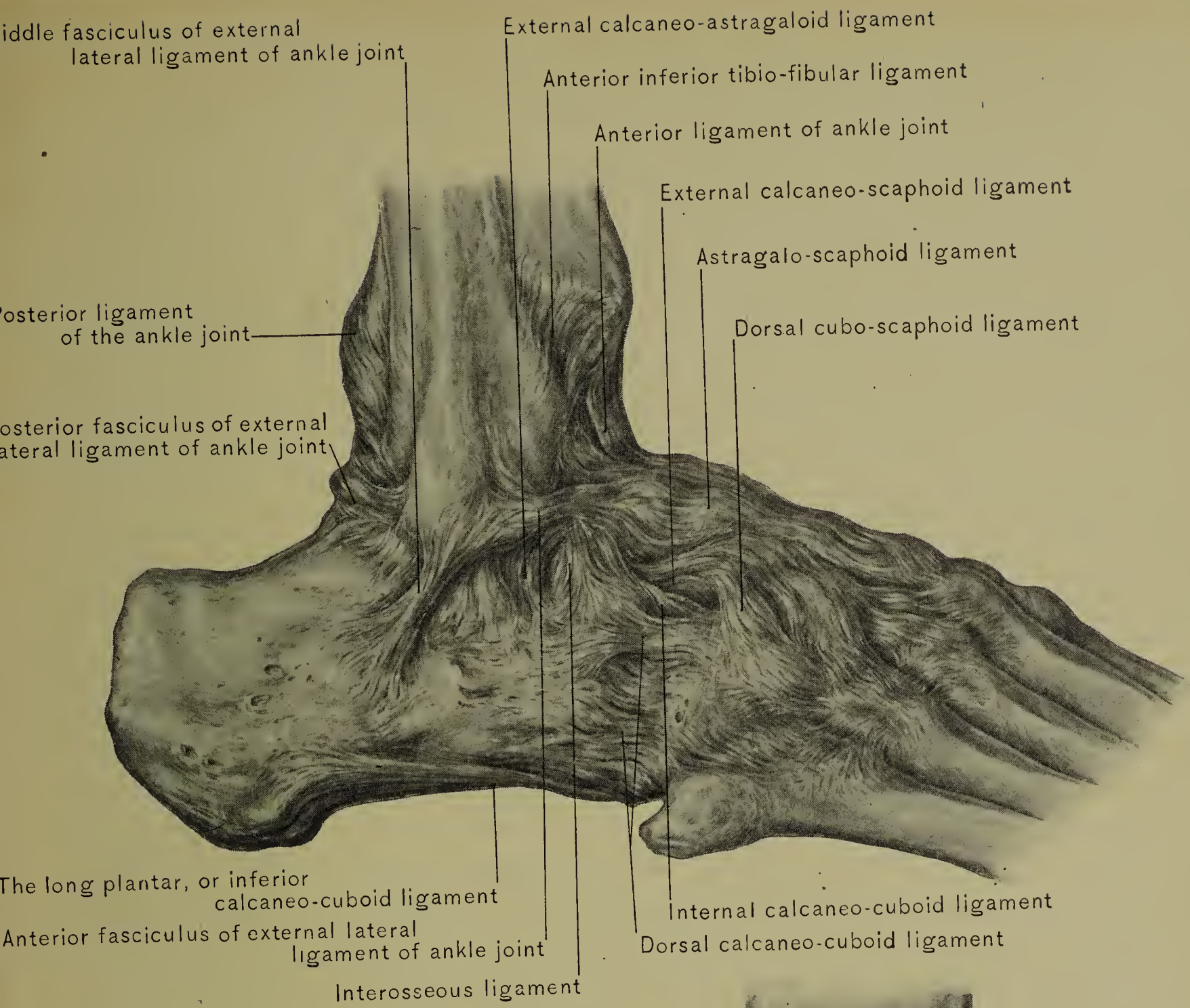
The *interosseous ligament* is the most powerful of the ligaments of this articulation, being the main bond of union between the bones. It consists of strong fibers which pass from the groove on the under side of the astragalus to the depression between the articular facets on the upper part of the os calcis. Strong fibers extend from the lower external surface of the neck of the astragalus to the anterior upper surface of the os calcis, forming the posterior boundary of the anterior calcaneo-astragaloid joint. These fibers are called the anterior interosseous ligament.

The *antero-internal calcaneo-astragaloid ligament* connects the internal surface of the neck of the astragalus to the upper edge of the free border of the sustentaculum tali. It blends posteriorly with the interosseous ligament, and anteriorly with the inferior astragalo-scaphoid ligament. The internal lateral ligament strengthens it.

The *external calcaneo-scaphoid ligament* forms the external limits of this as well as of the calcaneo-scaphoid articulation. It will be described with the latter joint.

The *synovial sac* is continuous with that of the astragalo-scaphoid joint.

The **posterior calcaneo-astragaloid articulation** is formed by the facet on the



LIGAMENTS OF TARSUS—EXTERNAL AND INTERNAL VIEW.

body of the astragalus and the posterior facet on the upper surface of the os calcis. The ligaments of this joint are the interosseous, external and internal calcaneo-astragaloid, and the posterior calcaneo-astragaloid.

The *interosseous ligament* has been described.

The *external calcaneo-astragaloid ligament*, short and strong, passes from the groove on the external surface of the astragalus to the external surface of the os calcis below its articular margin. It lies on a deeper plane than the middle fasciculus of the external lateral ligament of the ankle, and somewhat in front of it, the general course of the fibers of the two, however, being the same.

The *internal calcaneo-astragaloid ligament* passes from the tubercle of the astragalus, obliquely downward and backward, to the sustentaculum tali.

The *posterior calcaneo-astragaloid ligament* closes in the calcaneo-astragaloid articulation behind. It passes from the external tubercle of the astragalus to the os calcis, being attached to the latter bone a variable distance from its articular margin.

The *synovial sac* is not connected with any other.

BLOOD SUPPLY.—The joints are supplied by branches of the posterior tibial, dorsalis pedis, and peroneal arteries.

NERVE SUPPLY.—This is derived from the posterior tibial or plantar nerves.

MOVEMENTS.—These joints allow adduction, abduction, and some rotation.

The Medio-tarsal Articulations.—This set includes the astragalo-scaphoid and the calcaneo-cuboid articulations.

The **astragalo-scaphoid articulation** is formed by the head of the astragalus fitting into the depression formed by the posterior surface of the scaphoid, the anterior articulating surface of the calcaneum, and the upper surface of the lower calcaneo-scaphoid ligament.

The *astragalo-scaphoid* is the only ligament of this joint. It is a membranous band found on the dorsum of the foot. It passes obliquely forward from the head of the astragalus to the superior surface of the scaphoid (navicular) bone.

Two other ligaments, while not attached to the astragalus, strengthen and steady the joint. These are the *external calcaneo-scaphoid* and the *inferior calcaneo-scaphoid ligaments*, that hold together the calcaneum and scaphoid, the bones, however, not articulating.

The *external calcaneo-scaphoid ligament* is attached, in conjunction with the internal calcaneo-cuboid, in the inner astragalo-calcanean sulcus. It passes from the inner side of the calcaneum to the outer side of the scaphoid.

The *inferior calcaneo-scaphoid ligament*, strong, broad and thick, extends from the front and inner extremity of the under surface of the calcaneum to the inferior

surface of the scaphoid. This ligament is wide, and helps form the articular cavity for the head of the astragalus. Above, it is covered with synovial membrane, while below it is the tendon of the tibialis posticus.

The *synovial sac* found in this joint is continuous with the one found in the anterior calcaneo-astragaloid joint.

The **calcaneo-cuboid articulation** is held in place by four ligaments, two plantar and two dorsal.

The *long calcaneo-cuboid ligament* (long plantar) is the longest of the tarsal ligaments. It is superficial to the short plantar; its fibers extend from the under surface of the os calcis to the ridge of the under surface of the cuboid, some of them, however, passing forward to be inserted into the bases of the third, fourth, and fifth metatarsal bones. It covers the peroneus longus muscle.

The *short calcaneo-cuboid ligament* (short plantar) lies close to the bones, being separated from the long plantar ligament by a small amount of adipose tissue. It is very broad but short, being but an inch (2.5 centimeters) in length. It passes from the tubercle of the calcaneum to the inferior surface of the cuboid behind the ridge.

The *dorsal calcaneo-cuboid ligament* is a narrow band which passes from the upper surface of the calcaneum to the upper surface of the cuboid.

The *interosseous* (*internal calcaneo-cuboid*) *ligament* forms one of the strongest bonds of union between the first and second row of tarsal bones. It is a short and thick band of fibers found in the hollow between the astragalus and calcaneum. It is blended with the external calcaneo-scaphoid ligament and is inserted into the cuboid on its inner side.

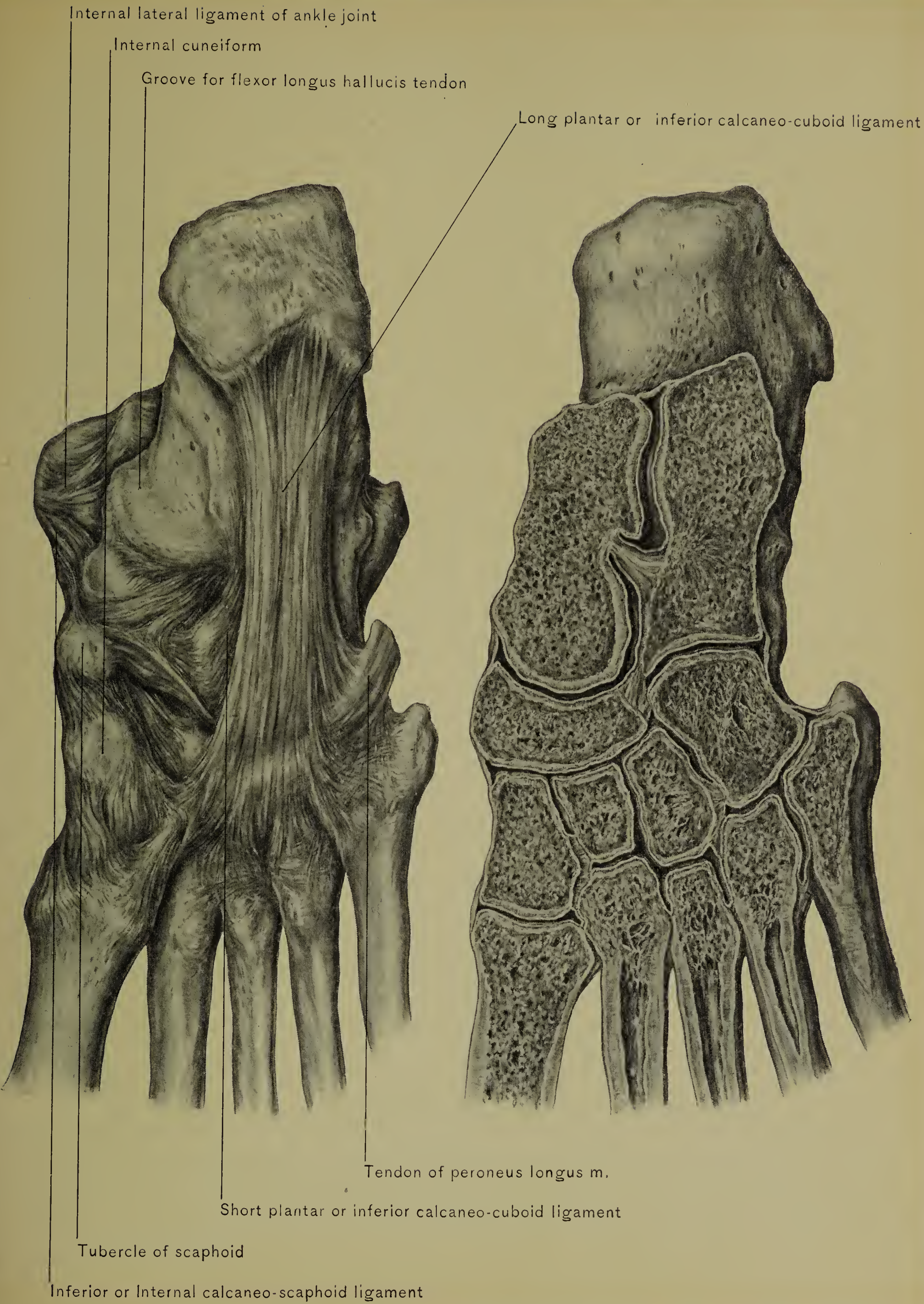
The Articulations of the Anterior Part of the Tarsus.—This set includes the cubo-scaphoid, scapho-cuneiform, inter-cuneiform, and cubo-cuneiform joints.

The **scapho-cuneiform articulation** is formed by the three cuneiform bones anteriorly and by the scaphoid posteriorly. The ligaments of the articulation are the dorsal, the plantar, and the internal ligaments. The *dorsal ligament* passes obliquely between the dorsal surface of the scaphoid and the cuneiform bones. The *internal ligament* connects the tubercle of the scaphoid with the inner surface of the internal cuneiform bones and passes around the inner side of the articulation to become blended with the plantar ligament. The *plantar ligament* is of the same arrangement as the dorsal, being strengthened, however, by small strips given off from the tendon of the tibialis posticus muscle.

The **scapho-cuboid articulation** has three ligaments—a dorsal, a plantar, and an interosseous.

The *dorsal*, composed of short fibers, extends obliquely between the two bones.

The *plantar* passes transversely between them.



(A) LIGAMENTS OF THE FOOT, PLANTAR SURFACE. (B) SECTION SHOWING THE SYNOVIAL CAVITIES OF THE FOOT.

The *interosseous* intervenes between their adjacent surfaces.

The **intercuneiform** and the **cubo-cuneiform articulations** are held together by dorsal, plantar, and interosseous ligaments.

The *dorsal ligaments* are made up of three bundles, two connecting the cuneiform bones with each other and the third the external cuneiform with the cuboid. They pass transversely.

The *plantar ligaments* are two in number. One unites the internal with the middle cuneiform; the other, the external with the cuboid. They are strengthened by strips from the tendon of the posterior tibial muscle.

The *interosseous ligaments* are three in number and connect the cuneiform bones with each other and the external cuneiform bone with the cuboid.

The *synovial membranes* of the intercuneiform, the cubo-cuneiform, and the scapho-cuboid articulations are parts of the great tarsal synovial membrane.

THE TARSO-METATARSAL ARTICULATIONS.

The articulations of the tarsal with the metatarsal bones may be divided into three sets: the internal, between the internal cuneiform and first metatarsal bones; the middle, between the three cuneiform and the second and third metatarsal bones; and the external, or cubo-metatarsal, between the cuboid and the fourth and fifth metatarsal bones.

The **Internal Articulation** is supported by a *capsular ligament*, which is strong on its plantar aspect, and blends with the scapho-cuneiform ligament.

The **Middle Articulation**, formed by the three cuneiform and the second and third metatarsal bones, is supported by dorsal, plantar, and interosseous ligaments.

The *dorsal ligament* is formed by bands that unite the three cuneiform bones to the bases of the metatarsals.

They vary in their arrangement between the articulating bones, the internal cuneiform being attached to the second metatarsal by a narrow fibrous band; the second metatarsal receives a slip from each of the cuneiform bones, and the third metatarsal receives but one, from the external cuneiform.

The *plantar ligaments* are less regular than the dorsal. Oblique bands connect the internal cuneiform to the second and third metatarsal bones, while others pass transversely from the external cuneiform to the third metatarsal.

The *interosseous ligaments* are internal, middle, and external; the *internal* passes from the internal cuneiform to the second metatarsal; the *middle* passes from the external cuneiform to the second metatarsal bone; and the *external* passes from the outer side of the external cuneiform to the third and fourth metatarsal bones.

The **External** or **Cubo-metatarsal Articulation** is also supported by dorsal, plantar, and interosseous ligaments.

The *dorsal ligament* passes from the cuboid to the bases of the fourth and fifth metatarsals, and forms part of the capsule of the joint.

The *plantar ligament* extends from the cuboid to the bases of the fourth and fifth metatarsal bones as a strong band. It becomes continuous at the outer side of the fifth metatarsal bone with the dorsal ligament, and internally with the interosseous ligaments, completing the capsule.

The *interosseous ligament* divides the cubo-metatarsal from the middle tarso-metatarsal joint. It extends from the external cuneiform to the apposed surfaces of the third and fourth metatarsal bones.

There are three *synovial sacs* in relation with the tarso-metatarsal articulations, one between the internal cuneiform and the first metatarsal; a second or middle sac is found between the middle and external cuneiform and the second and third metatarsal, and is continuous with the scapho-cuneiform and inter-cuneiform joints; and the third is between the cuboid and the fourth and fifth metatarsals.

BLOOD SUPPLY.—The blood supply of the tarso-metatarsal joints is derived from the dorsalis pedis, the plantar, and metatarsal arteries.

NERVE SUPPLY.—This is derived from the anterior tibial and plantar nerves.

MOVEMENTS.—These joints permit of flexion and extension of the metatarsus on the tarsus, and gliding, which latter diminishes or increases the arch of the foot.

THE INTERMETATARSAL ARTICULATIONS.

The metatarsal bones are held together at their bases by dorsal, plantar, and interosseous ligaments; and at their heads by a plantar transverse ligament.

The *dorsal ligaments* unite the four outer metatarsal bones on their dorsal aspect. The ligament from the internal cuneiform to the base of the second metatarsal bone acts as a dorsal ligament between the first and second metatarsal bones.

The *plantar ligaments* are strong and well marked and connect the bases of the bones on their plantar surfaces.

The *interosseous ligaments* connect the non-articular surface beyond the bases of the bones and limit the synovial cavities.

At their heads these bones are united by a strong *transverse plantar ligament* that blends with the sheath of the flexor tendons. It differs from its counterpart in the hand in that a slip passes from the first to the second metatarsal bone.

BLOOD SUPPLY AND NERVE SUPPLY.—These are the same as in the tarso-metatarsal articulations.

MOVEMENTS.—These consist in gliding, to raise or flatten the transverse arch of the foot.

THE METATARSO-PHALANGEAL ARTICULATIONS.

These joints are formed by the rounded heads of the metatarsal bones and the cup-like depression in the base of the corresponding first phalanges. The joints are supported by a dorsal and two lateral ligaments, and by a plantar sesamoid plate.

The *lateral ligaments* are identical in their arrangement with their counterparts in the hand. Connecting the sides of the articulating bones, they are united above by the dorsal ligament.

The *dorsal ligament* extends between the lateral ligaments and completes the capsule and is connected with the extensor tendons.

The *plantar sesamoid plate* deepens the facet on the head of the phalanx and thus prevents dislocation. Its counterpart in the hand is the *glenoid ligament*. This latter, however, is absent in the great toe, being replaced there by sesamoid bones developed in the tendon of the flexor brevis hallucis muscle.

The *synovial membrane* is quite loose.

BLOOD SUPPLY.—From the digital arteries.

NERVE SUPPLY.—From the cutaneous, digital, or interosseous branches of the anterior tibial and the plantar nerves.

MOVEMENTS.—These joints permit flexion, extension, abduction, adduction, and circumduction.

THE INTERPHALANGEAL ARTICULATIONS.

These joints are similar to those in the fingers, with the exceptions that the bones are smaller and that the joints are often ankylosed. The ligaments that support the joints are the two lateral, the dorsal, and the glenoid.

The *lateral ligaments* connect the sides of the head and base of the corresponding phalanges.

The *dorsal ligaments* unite the lateral ligaments and are connected with the extensor tendons.

The *glenoid ligaments* (fibro-cartilaginous plates) protect the joints on their plantar surface, and are grooved by the flexor tendons.

BLOOD SUPPLY AND NERVE SUPPLY.—The blood and nerve supply is derived from the digital arteries and nerves.

MOVEMENTS.—These are restricted to flexion and extension.

THE FOOT AS A WHOLE.

The **Foot** is composed of seven bones of the tarsus, five of the metatarsus, and fourteen phalanges—a total of twenty-six. The foot joins the leg at right angles, and this peculiarity, together with the similar cranio-vertebral junction, occurs but seldom in any of the lower animals.

The main arches of the foot are two—longitudinal and transverse.

The **longitudinal arch** extends from the heel to the metatarso-phalangeal joints, its summit being crowned by the astragalus, upon which are mounted the leg bones. It is divided into a posterior limb, composed of the astragalus and os calcis, and an anterior limb, formed by the rest of the tarsus and the metatarsus beyond.

The *posterior limb* is half as long as the anterior, with a consequent less gradual ascent. The foot being viewed as a lever of the second class, with the weight upon the continuity of the lever (between its ends), the fulcrum is at the ball of the foot, while the power is applied at the heel by the tendo Achillis. The shortness of the posterior limb of the pedal arch conduces to celerity of movement at the expense of power, while its composition, of the thick heavy os calcis and back part of the astragalus, gives it the advantage of solidity for the leverage of the tendo Achillis, without loss of power through multiple joints and their movements.

The *anterior limb*, because of its numerous parts and their gliding synovial interstices, presents an elastic resistance to sudden impacts upon the ball of the extended foot, and thus lessens the jar upon the ankle, knee, hip, spinal column, and intracranial contents in the order named. In broad jumping the heel first strikes the ground, but the great momentum of the body quickly carries it forward upon the toes, thus rocking it upon the foot from heel to ball, the ultimate and greater strain falling upon the anterior limb of the arch.

Transversely, from behind forward, the arch is triangular, with its apex at the heel and its base at the ball of the foot. The widening of the anterior limb of the arch from the astragalus to the ball of the foot serves to distribute force along the five metatarsal bones to the ball of the foot.

The *anterior limb of the arch of the foot* is also longitudinally divisible into two pillars: an *inner pillar*, consisting of the astragalus, scaphoid, three cuneiform, and inner three metatarsal bones; and an *outer pillar*, formed by the os calcis, the cuboid, and the two outer metatarsal bones, the former being the real arch and the latter its lateral brace. In standing, most of the weight of the body is transmitted to the inner pillar, and because of the longer downward extension of the outer malleolar articulation of the astragalus, the weight is mainly thrown

upon the inner side of this pillar, falling eventually upon the ball of the great toe, where it is most ably borne. The cuboid braces more especially the external cuneiform bone just where it tends to bulge, besides receiving from the os calcis some weight which it transmits to the outer two metatarsal bones.

The **transverse arch** is most noticeable in the tarso-metatarsus, and adds to the stability of the longitudinal arch, especially in front, where it is a material aid to prevent undue spreading at the metatarsus and ball of the foot, besides providing additional elasticity.

Flat-foot consists in a lowering of the inner pillar of the pedal arch by sinking of the astragalo-scaphoid junction. This is peculiar to some people and is due to habitual strain early in life, and to cramping the foot in thick heavy shoes during growth. The highest types of human beings have a high arch. Even adults carrying very heavy loads often become flat-footed from gradual yielding of the calcaneo-scaphoid, and the long and short calcaneo-cuboid ligaments, the plantar fascia, and the tendons of the anterior and posterior tibials and of the peroneus longus, resulting in the rolling downward and inward of the head of the astragalus, and the descent of the inner scaphoid tuberosity, inner cuneiform, and first metatarsal base. Cessation from strain incident to heavy carrying, and the regular performance of suitable gymnastic exercises, at times effect a cure. Otherwise the astragalo-scaphoid joint may be opened, its cartilage scraped away, and the foot properly arched and so held until ankylosis of the joint results in the proper position.

In the **negro-heel** the posterior limb of the arch is elongated, while there is also a shallowness of the transverse arch, and more of the outer edge of the foot touches the ground. This condition is still more exaggerated in the monkey.

The **lateral arch** of the foot is convex externally from the heel to the base of the little toe, giving the best basis of support for the leg and its superimposed weight, which, because of the inward direction of the femur and lower end of the tibia, is directed downward and inward. On this account it is also appropriate that the inner side of the foot is much stronger and more arched, as the downward pressure is radiated outward, forward, and backward from it, to the calcaneo-cuboid arch, the ball, and the heel respectively.

Another advantage of the plantar arches consists in the security from compression they afford the plantar muscles, vessels, tendons, and nerves.

The arches of the foot are maintained by the bridge or keystone arrangement of the bones, specially noticeable in the cuneiform bones and bases of the metatarsals in preserving the transverse arch, and the ligaments, tendons, and muscles. One of the most important structures in the maintenance of these curves is the

tendon of the peroneus longus, which, it will be remembered, passes downward behind the outer malleolus, then through grooves on the outer side of the os calcis and under side of the cuboid, to be attached to the under surface of the base of the great toe. It thus assists in the support of both the longitudinal and transverse arches. The long calcaneo-cuboid ligament, extending longitudinally between the two ends of the long arch, forms its most important tie or brace.

Talipes, or **Club-foot**, consists in such permanent adduction, abduction, extension, or flexion of the foot, even in walking, that only the outer or inner side of the foot, or the ball, or the heel, respectively touches the ground; or combinations of these may occur.

The commonest form is **equino-varus**, in which the heel is drawn upward and the outer side of the foot and ball rest upon the ground. It is often congenital, and is then a continuance of the normal intra-uterine position of the foot, probably due to pressure from the uterine wall. To remedy this evil, tenotomy is necessary, and this should be performed as early as possible to prevent permanent changes in the shape of the bones. This is true even in the acquired talipes of adults. The tendons requiring severance in this trouble are the tendo Achillis, which sometimes is sufficient, the tibialis anticus, tibialis posticus, and flexor longus digitorum, and the front of the deltoid ligament attached to the scaphoid tuberosity, the inner part of the plantar fascia, and perhaps even the abductor of the great toe; in fact, anything requisite must be severed to permit the restoration of the foot. Care should be taken not to cut tendons in their synovial sheaths, as then they may not unite, but they will do so if severed beyond their sheaths. In adults it is sometimes necessary to remove a wedge of bone from the top and inner side of the instep, or the astragalus may be excised.

In **talipes valgus** the outer edge of the foot is drawn off the ground and the patient walks upon the depressed inner pillar of the longitudinal pedal arch; it is rare.

In **talipes calcaneus** the patient walks upon the heel, the ball of the foot being held off the ground. It may be due to contraction of the extensor muscles, the tendons of which should then be divided, or to paralysis of the calf muscles, in which event an oblique segment is to be taken from the relaxed tendo Achillis and the severed ends spliced.

In **talipes equinus** the patient walks upon the ball of the foot, the heel being held off the ground. The tension in the long digital extensors draws the toes backward upon the foot, while the long digital flexors hold down the ungual phalanx. Sometimes the toes are partially dislocated upon the dorsum of the metatarsus, but can generally be replaced by forcible flexion of the ankle.

Pes cavus consists in a permanently elevated heel associated with an exagger-

ated curve of the foot due to contracture of the plantar fascia similar to that of the palm producing Dupuytren's contracture. It is treated, surgically, by section of the tendo Achillis and plantar fascia.

The **Toes** (with the exception of the great toe), within a pair of shoes, are substantially rudimentary organs. To a certain extent they exert leverage in walking by adding a final propulsive effort to that which sends the body forward, this being done by the digital flexors. They also serve to enlarge the area of the anterior base of the great longitudinal arch of the foot. They adapt the foot to surface inequalities in walking bare-footed. They are most diminutive in the highest types of human beings, and are much longer in all lower forms.

Hammer-toe usually affects the second toe; it consists in permanent hyper-extension at the metatarso-phalangeal joint, and permanent flexion of the two phalangeal joints. It is at times successfully treated by mechanical restraint, at others by tenotomy, but if the lateral ligaments of the extended joints have slipped behind the metatarsal head, amputation generally is the only remedy that promises relief.

Hallux valgus is a prominence and hypertrophy of the inner side of the base of the great toe due to forcible pressure from tight shoes, displacing the great toe toward the outer toes, under or over which it then generally lies. In its early stages it is successfully treated, at times, by wearing wide-toed shoes with soles having a straight inner edge, and by placing a pad between it and the second toe; but when advanced, a subcutaneous osteotomy of the neck of the metatarsal bone, an excision of the affected joint, or amputation of the toe is required. If of long standing, a subcutaneous bursa forms, which becomes a *bunion* if inflamed.

Operations for Talipes.—**Talipes valgus** may often be corrected by subcutaneous division of the tendons causing it. Among these are the peroneus tertius, the tendo Achillis, the extensor longus digitorum, and at times the tibialis anticus and extensor proprius pollicis. In dividing the tendons of the peroneus tertius and extensor longus digitorum, the tenotome should be introduced to the inner side of the latter, the tendons being divided from within outward. The other tendons requiring division may be divided through the same incision, with the exception of the tendo Achillis.

In **talipes varus** the tendons requiring division include the tendo Achillis, and those of the tibialis anticus, the tibialis posticus, the flexor longus digitorum, and the plantar fascia. The tendo Achillis may be divided by introducing the tenotome along the side of the tendon, on a level with its anterior margin, and cutting from within outward. In dividing the tendon of the tibialis posticus, the sharp-pointed tenotome should be introduced at a point immediately above the internal malleolus, and carried inward in close

relation with the posterior surface of the tibia, until the fascia in relation with the tendon has been opened. The tenotome should be withdrawn and the blunt-pointed one introduced in the same wound until it comes into the space between the tibia and the tendon. Its cutting edge is then turned against the tendon and the latter divided with a slight sawing motion.

In **talipes calcaneum** it will often be necessary to divide the tendons of the tibialis anticus, the extensor proprius pollicis, the extensor longus digitorum, and the peroneus tertius. All these tendons can be divided through a single puncture. The tenotome should be introduced to the inner side of the tendon of the extensor longus digitorum, in the front of the ankle. The instrument should be carried inward and the tendons of the extensor proprius hallucis and tibialis anticus divided; the tenotome should then be withdrawn and reintroduced, and carried in an outward direction, when the tendons of the peroneus tertius and extensor longus digitorum can be divided.

In passing the tenotome care must be taken to avoid wounding the anterior tibial artery which lies between the tendon of the tibialis anticus and that of the extensor longus digitorum.

In some cases of talipes varus simple tenotomy of the tendons will not suffice to allow the foot to be placed in its normal position. In such cases a resection of the tarsus is advisable. Some surgeons advocate the removal of the cuboid bone, but better results can be obtained by removing the astragalus, or a triangular piece from the tarsus. In performing this operation an incision should be made along the anterior border of the foot, beginning at the middle of the calcaneum, and carried forward to a point about an inch (2.5 centimeters) anterior to the tuberosity of the metatarsal bone of the little toe. A second incision should then be carried from the middle of the first incision to the outer side of the tendon of the extensor longus digitorum, at right angles to the first cut. The skin and superficial fascia, with twigs to the internal saphenous nerve, and a few cutaneous vessels will be divided. The tarsus will be exposed by reflecting the flaps. The tendons are to be lifted up, and a triangular piece of the tarsus removed with a metacarpal saw or, preferably, with an osteotome or chisel and mallet. No attention is paid to the lines of articulation between the several bones, but care must be taken to avoid wounding the soft structures of the sole of the foot.

In the combinations of these forms of talipes the offending tendons should be divided.

In **talipes equinus** usually the division of the tendo Achillis suffices to correct the deformity.

DISLOCATIONS.

The subject of luxations in general has been considered with the description of dislocations of the upper extremity.

The **femur** is liable to dislocation in one of four directions: upward and backward onto the dorsum ilii, upward and backward into the great sciatic notch, downward and forward into the thyroid foramen, and upward and forward onto the os pubis.

In the *dislocation onto the dorsum ilii*, the head rests upon the ilium just above and behind the acetabulum. The capsule is lacerated, especially in the posterior part, and the round ligament is almost always completely ruptured. The small external rotators of the thigh are put on the stretch, and the tendon of the obturator externus is markedly stretched across the posterior part of the neck of the bone. The gluteus maximus, medius, and minimus are generally relaxed and pushed upward. The ilio-femoral or Y ligament is rarely, if ever, torn. At times the great sciatic nerve may become injured by being carried around the neck in a loop. After the dislocation has been of some standing, the glutei muscles will contract, and thus render the reduction of the luxation much more difficult. The great trochanter is made very prominent. The thigh is rotated inward and abducted, more by the false position of the head than by the action of the muscles. The knee is drawn toward the opposite knee, and the ball of the great toe rests upon the dorsum of the other foot. The limb is shortened about three inches (7.5 centimeters).

In the *ischiatric variety* the head of the femur is forced through the posterior part of the capsule in a backward direction until it comes in contact with the strong tendon of the obturator internus muscle, which reflects the head into the sciatic notch. There is always extensive laceration of the posterior part of the capsule, and complete separation of the ligamentum teres. The gluteus maximus is often badly torn, and at times the head of the bone is found embedded in that muscle. The gluteus minimus, the gemellus superior, and the pyriformis are generally more or less torn. The head is often found resting upon the gemelli muscles, and either upon, or close to, the great sciatic nerve. At times the obturator externus is torn. The positions of the thigh and leg are about the same as in the dislocation upon the dorsum ilii.

In the *luxation into the thyroid foramen* the head of the bone is forced through the inner side of the capsule, which is extensively lacerated. The ligamentum teres is separated from the bone. The head of the femur rests upon the obturator externus muscle, over the thyroid foramen. The great trochanter is flattened, and the limb rotated and the toe pointed outward.

In the *luxation onto the os pubis* the capsular ligament is extensively lacerated and the ligamentum teres completely separated from the bone. At times the head of the bone will force its way under Poupart's ligament and rest upon the iliacus and psoas muscles, with the anterior crural nerve lying over the neck of the bone. Generally the head rests upon the pubes below Poupart's ligament. The trochanter disappears and at times occupies the acetabulum. The foot is everted by the action of the iliacus and psoas magnus muscles, and the outer band of the Y ligament.

The **patella** may be dislocated outward, inward, upward, or upon its axis.

In the *outward dislocation* the patella is found riding over the external condyle, unless the luxation be complete, when the patella will be found on the external aspect of the knee-joint. The ligamentum patellæ will be tense, and may at times be lacerated. The quadriceps extensor muscle will be tense. The articular surface of the internal condyle can be plainly felt. The internal lateral ligaments and many of the fibers of the tendinous expansions will be torn.

In the *inward luxation* the anatomical conditions will be the same as those in the outward variety, reversed.

In both varieties there will be inability to flex the knee, as the quadriceps is unable to act on account of the anomalous position of the patella.

In the *luxation in which the patella is rotated on its axis*, there is tightening of the quadriceps extensor muscle and the ligamentum patellæ, with stretching or laceration of the lateral ligaments. In the upward dislocation of the patella there is always extreme stretching of the ligamentum patellæ or rupture of the same, usually the latter.

The patella is carried upward for two or three inches (5.0 to 7.5 centimeters) by the quadriceps extensor muscle.

Dislocation of the knee may be forward, backward, inward, outward, or by rotation, the tibia in each case taking the direction indicated.

In the *backward luxation of the head of the tibia* there is marked depression immediately below and to either side of the patella. The head of the tibia is felt in the popliteal space. If the luxation be complete, there will be marked pain, owing to the pressure upon the popliteal nerves. The condyles can be felt projecting forward. The posterior ligaments of the joint are lacerated and the semimembranosus, the semitendinosus, and the biceps muscles are stretched. The popliteal vessels and nerves are pressed upon, and may at times be torn. If the dislocation be complete, the crucial ligaments will be torn. The gastrocnemius, popliteus, and plantaris muscles will be stretched and at times lacerated. All the parts connected with the joint will suffer from laceration, stretching, or pressure.

In the *forward luxation of the head of the tibia*, the patella, the head of the tibia, and the fibula will be plainly felt in front, while the condyles of the femur will project behind. The gastrocnemius, popliteus, and plantaris muscles will be greatly stretched, and the vessels and nerves of the popliteal space pressed against the condyles. The popliteal artery may be so pressed upon that the pulsations in the branches below may be interrupted, leading, at times, to gangrene of the parts supplied. The capsule is often lacerated, and the crucial and lateral ligaments either torn or put on the stretch.

The *lateral luxations* are generally incomplete, on account of the great width of the joint surfaces, and the strong lateral ligaments. In the internal or inward dislocation the head of the tibia will be felt on the inner side of the condyle of the femur. In the partial variety the inner condyle rests on the outer articulating surface of the tibia. The lateral ligaments are either greatly stretched or torn, and the crucial ligaments generally torn. The tendons of the hamstring muscles will be pulled to one side, and the contents of the popliteal space may be pulled out of place. In the outward variety the anatomical signs are practically the same as those of the inward variety, reversed.

Dislocation of the Fibula.—The upper end of the fibula may be dislocated forward or backward.

In the *forward variety* the head of the fibula is carried forward and presents in front near the ligamentum patellæ. The posterior superior tibio-fibular ligament is greatly stretched, and the anterior generally lacerated. The direction of the tendon of the biceps muscle is altered, and at times there is a considerable deformity in the shape and position of the leg.

In the *backward dislocation*, the head of the fibula is carried backward, and presents beneath the skin on the outer side of the popliteal space. The tendon of the biceps is very evident. The anterior and superior tibio-fibular ligaments are stretched or partially lacerated. The external popliteal nerve may suffer injury.

Dislocations of the foot or ankle may be backward, forward, inward, or outward. These dislocations are classed as luxations of the bones of the leg by many writers. In these descriptions, where the tibia is taken as the bone luxated, the direction of the dislocation is opposite to that here described.

In the *backward dislocation* the foot is carried backward, the tibia resting on the scaphoid bone if the luxation be complete, and on the neck or head of the astragalus if it be incomplete. The posterior tibio-tarsal ligament is greatly stretched or torn, and the anterior and lateral ligaments are lacerated. There is generally a fracture of the lower part of the fibula and a separation of the malleolus of the tibia. The tendo Achillis stands out prominently, being carried backward with the foot. The heel is lengthened and the foot shortened; the calcaneum

is made very prominent. The tendons, nerves, and vessels passing behind the malleoli may be thrown out of place and severely injured.

In the *forward dislocation*, the astragalus presents in front of the lower end of the tibia, the latter resting on the calcaneum. The tendo Achillis loses its prominence. This luxation is generally complicated by fracture of both malleoli. The anterior and lateral ligaments are ruptured and the posterior ligament is greatly stretched or torn; the foot is lengthened.

In the *outward dislocation* of the foot the external lateral ligament is ruptured and the outer malleolus is broken, or, instead, there is a break of the fibula (Pott's fracture). At times the internal malleolus will also be broken. The anterior and posterior ligaments are stretched or torn. Owing to the subcutaneous position of the malleoli, this dislocation is generally compound.

In the *inward luxation* the anatomical signs are the same as those of the outward variety, reversed. This luxation is almost always compound.

Dislocations of the astragalus may be forward, backward, or lateral.

In the *forward luxation* the astragalus is disjoined from the calcaneum and moves forward in front of the scaphoid and rests on the internal cuneiform bone. The anterior and posterior tibio-tarsal ligaments are stretched or torn, and the external, internal, and posterior calcaneo-astragaloid ligaments are ruptured or stretched. The interosseous ligament between the calcaneum and the astragalus is also torn.

In the *backward variety* the astragalus escapes posteriorly from the inter-malleolar space and from the calcaneum and scaphoid. It rests on the posterior part of the calcaneum, generally between the tibia and the tendo Achillis. The ligaments stretched or ruptured are the same as those affected in the forward luxation.

In the *lateral varieties* the astragalus escapes to the side of the ankle, its escape being allowed by fracture of the malleolus of that side. The same ligaments are stretched or ruptured as in the antero-posterior varieties.

The *incomplete congenital luxation* of the astragalus met with in certain forms of club-foot has been considered under the description of that condition.

“**Subastragaloid dislocation**” is a term applied by Malgaigne to a separation of the calcaneum and scaphoid bones from the astragalus, the latter remaining in its normal position in the mortise between the two malleoli. The luxation may be forward, backward, inward, or outward.

In the *forward variety* the astragalus rests on the facets of the calcaneum; in the *backward*, upon the scaphoid or cuboid bones; in the *outward*, upon the cuboid bone; in the *inward*, upon the tuberosity of the scaphoid. In all of them the tibio-tarsal ligaments remain intact, but the external, internal, and posterior

calcaneo-astragaloid ligaments, the interosseous, and the superior astragaloscaphoid ligaments are torn. In the outward variety the tendons of the tibialis anticus and the tibialis posticus are stretched, the former over the neck of the astragalus, and the latter against the groove of the tibia.

The **calcaneum** may be dislocated *outward* from the astragalus, or *outward and upward* from the astragalus and the cuboid. In the former variety the external and posterior calcaneo-astragaloid ligaments will be stretched and the internal calcaneo-astragaloid and the interosseous either greatly stretched or torn. The tendo Achillis will be carried outward with the bone to which it is attached. If the connection with the cuboid be also severed, the superior, inferior, long, and short calcaneo-cuboid ligaments will be either stretched or torn, in addition to those above enumerated.

Dislocations of the remaining bones of the tarsus are very rare, and when they do occur are generally associated with a fracture of some of the adjoining bones. There is a laceration of all the various ligaments connecting the bones, and marked deformity depending upon the extent of the injury and the bones displaced.

Dislocation of the metatarsal bones may occur either singly or of the entire number. The dorsal plantar and the interosseous ligaments are either stretched or torn, and the tendons and vessels lying over or under the joints may be seriously injured.

Dislocations of the phalanges of the toes may occur, although they are comparatively rare. These take place in a forward and backward direction.

In the *dislocation of the proximal phalanx* of the great toe there is always difficulty experienced in effecting a reduction. No definite reason has been given for this trouble.

In these dislocations the plantar and two lateral ligaments are either stretched or torn.

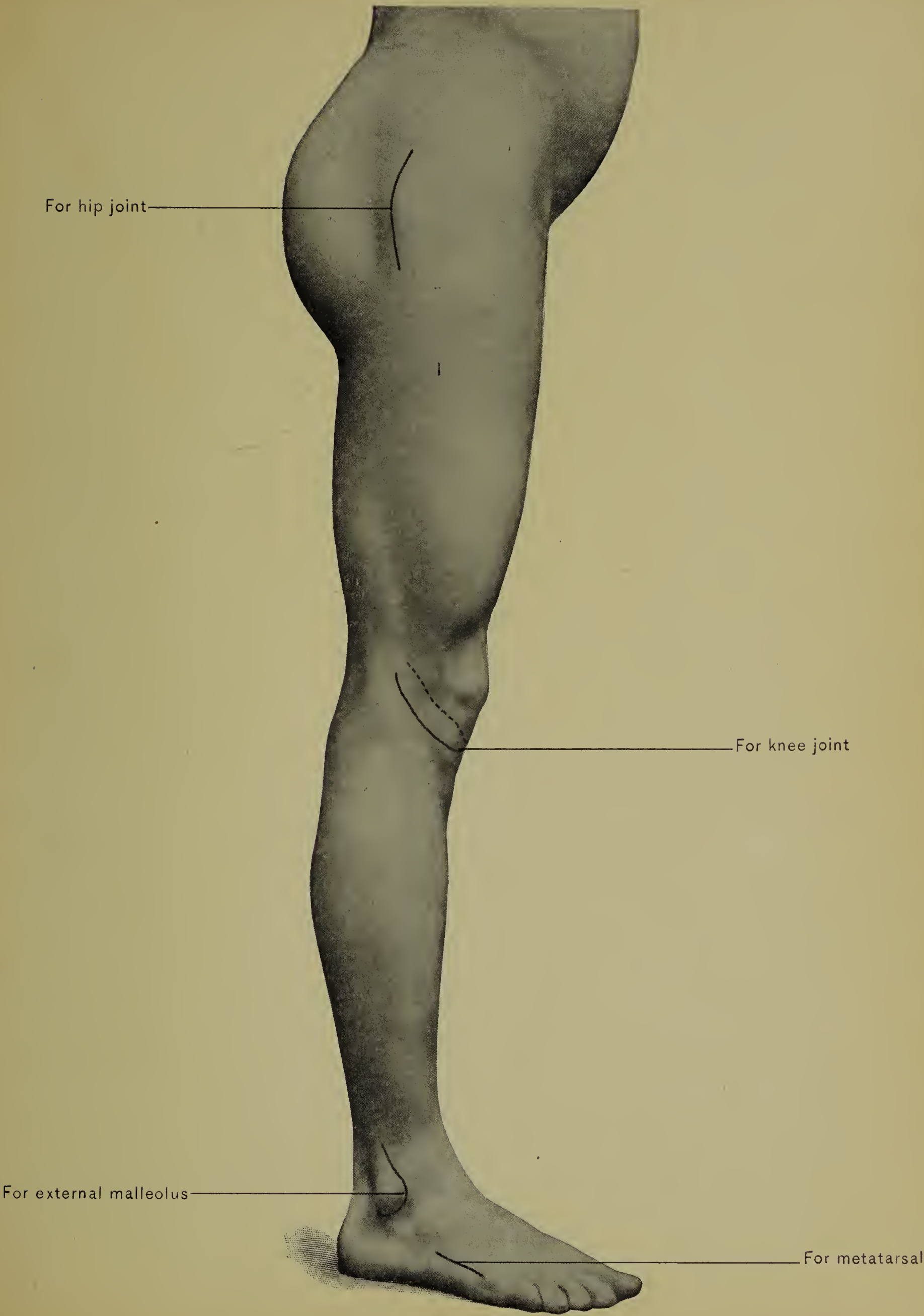
EXCISIONS OF THE LOWER EXTREMITY.

The subject of excision has been discussed with the description of the excisions of the upper extremity.

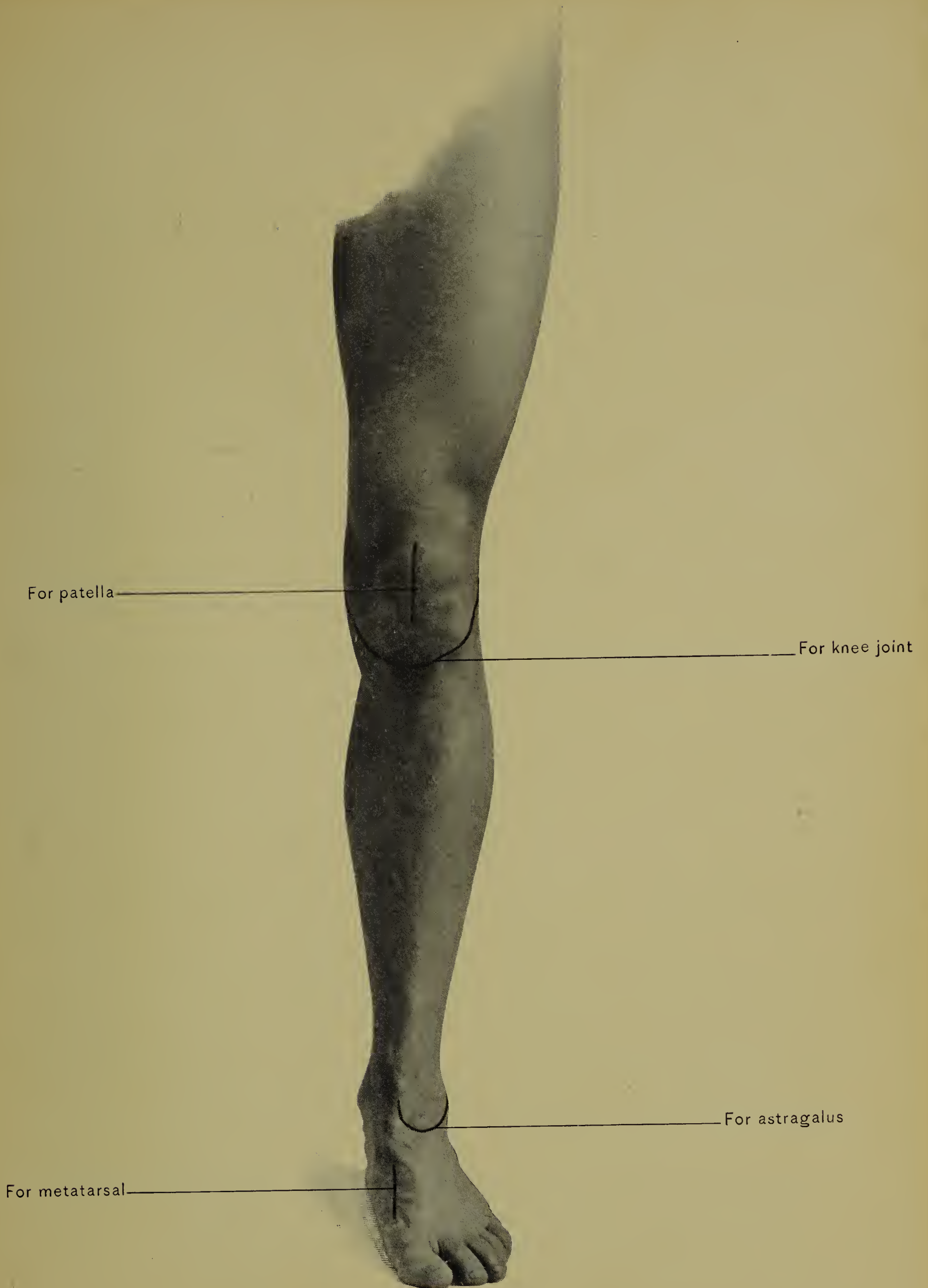
Excision of the Hip-joint.—In excising the hip the patient should lie on the sound side, with the thigh of the affected limb flexed. A slightly curved incision is then to be made, beginning about an inch and a half (3.75 centimeters) above the great trochanter, and, after skirting the posterior border of the base of this process, ending about two inches (5.0 centimeters) below it. The incision should be freely made and reach to the bone. The skin and superficial fascia will be divided, with branches of the first and second lumbar, the lateral branch of the

twelfth dorsal, and the iliac branch of the ilio-hypogastric nerves; small branches from the external cutaneous nerve and from the lesser sciatic; branches of the gluteal and small sciatic arteries and their veins; the deep fascia, the three glutei muscles nearly in the line of their fibers, muscular and articular branches of the gluteal and small sciatic arteries, the capsule of the joint, and the periosteum. If the great trochanter has to be removed, the muscles attached to it,—the gluteus medius and minimus, the piriformis, the gemellus superior and inferior, the obturator externus and internus, part of the quadratus femoris,—must be divided and the periosteum separated from the bone. The capsule is freely opened and the head of the bone brought into the wound by dividing the ligamentum teres and then carrying the thigh well forward. As much of the bone as is to be removed should be cleared of its periosteum, and the diseased bone removed with a saw.

Excision of the Knee-joint.—In excising the knee-joint the excision should be made transversely across the front of the knee-joint, with the leg flexed. The incision starts at the posterior edge of the base of the condyle and is carried directly across the front of the joint to a similar point on the opposite condyle. The first cut should divide all the structures down to the joint. The structures divided will be the skin and superficial fascia, twigs of the internal cutaneous and of the cutaneous branch of the popliteal nerves, and small arteries with their veins, the ligamentum patellæ, and the capsule of the joint. The skin and superficial fascia with the ligamentum patellæ and the patella should be dissected upward as far as necessary and all the structures divided down to the bone in the line of the proposed section. The crucial and the internal and external lateral ligaments are to be divided and the diseased parts removed with a saw. On account of the obliquity of the femur, and because the epiphyseal line is somewhat higher on the anterior than the posterior surface of the bone, the “section of the condyles should be in a plane which, as regards the axis of the femur, is oblique from behind forward, from below upward, and from within outward.” The tibia should be divided in a plane at right angles to the shaft of the bone. In making the section of the femur and tibia it is advisable to saw from behind forward, and thus avoid the possibility of injuring the popliteal vessels, especially the artery, which are separated from the posterior surface of the joint by the posterior ligament. With the leg extended, the popliteal artery lies against the posterior ligament of the joint; but with the leg flexed, the artery is carried away from the ligament. The patella is to be removed, as a rule, whether diseased or not. This will necessitate division of the tendo patellæ, formed by the union of the four muscles forming the quadriceps extensor—namely, the vastus externus, the vastus internus, the rectus, and the crureus. If the parts be



LINES OF EXCISIONS.



LINES OF EXCISIONS.

much diseased, there will be considerable bleeding on account of the anomalous condition of the arterial supply to the joint. The vessels usually requiring ligation are branches of the four articular arteries and of the tibial recurrent. When the disease extends into the bursa beneath the quadriceps extensor muscle, the dissection should be carried upward far enough to remove the entire bursa.

The **patella** may require excision on account of injury or disease. A longitudinal incision is made directly over the bone. The skin and superficial fascia are divided, with twigs of the internal cutaneous and of the cutaneous branch of the popliteal nerves, small arteries and their veins. The patella is exposed and its fibrous covering divided in the line of the original incision. The bone or its fragments are removed, with as little of the soft parts as possible.

Excision of the Ankle-joint.—In excising the ankle-joint by the subperiosteal method two incisions should be employed, one over each malleolus. The external incision is made along the anterior edge of the fibula to the tip of the external malleolus, then curving backward around the process. The internal incision is similarly made with regard to the tibia. The skin and superficial fascia will be divided, with twigs of the internal saphenous nerve on the internal aspect and of the external saphenous and musculo-cutaneous on the external aspect of the leg. Small branches of the anterior and posterior tibial arteries with their veins will also be severed. The periosteum of the fibula should then be divided longitudinally and stripped from the bone in anterior and posterior flaps. Division of the external lateral ligament will be required, and this should be performed in a vertical direction, in order to preserve its usefulness as much as possible. The external malleolus should then be removed, either with the chisel or the saw. The periosteum over the internal malleolus, the internal lateral ligament, and the internal malleolus should then be similarly treated. The astragaloid ligaments are divided with a blunt-pointed knife, and as much of the astragalus removed as is thought necessary. Usually the entire bone is taken out.

Excision of the Astragalus.—In *excising the astragalus* a semilunar incision is made on the anterior and external aspect of the joint. The skin and superficial fascia are divided, with twigs of the external saphenous and musculo-cutaneous nerves, and small branches of the posterior tibial or plantar arteries. The external lateral ligament is divided and as much of the bone removed as required.

Excision of the Os Calcis.—If it be necessary to excise the calcaneum or a portion of it, an incision may be made by one of several methods. Holmes recommends an incision beginning at the inner edge of the tendo Achillis, and carried through the tendo Achillis and around the outer aspect of the foot on a level with the upper border of the bone to a point midway between the heel and

the base of the fifth metatarsal bone. A second incision is then carried from the anterior end of the first incision, and at right angles to it, downward and across the plantar surface of the heel to the inner grooved surface of the calcaneum. The flap is dissected from the bone, carrying with it the divided tendons of the peroneal muscles. The ligaments between the calcaneum and the cuboid are then divided and the calcaneum tilted inward, when the calcaneo-astragaloid ligaments are to be divided. The bone is then to be twisted outward and the soft parts separated from its inner surface, thus freeing the bone.

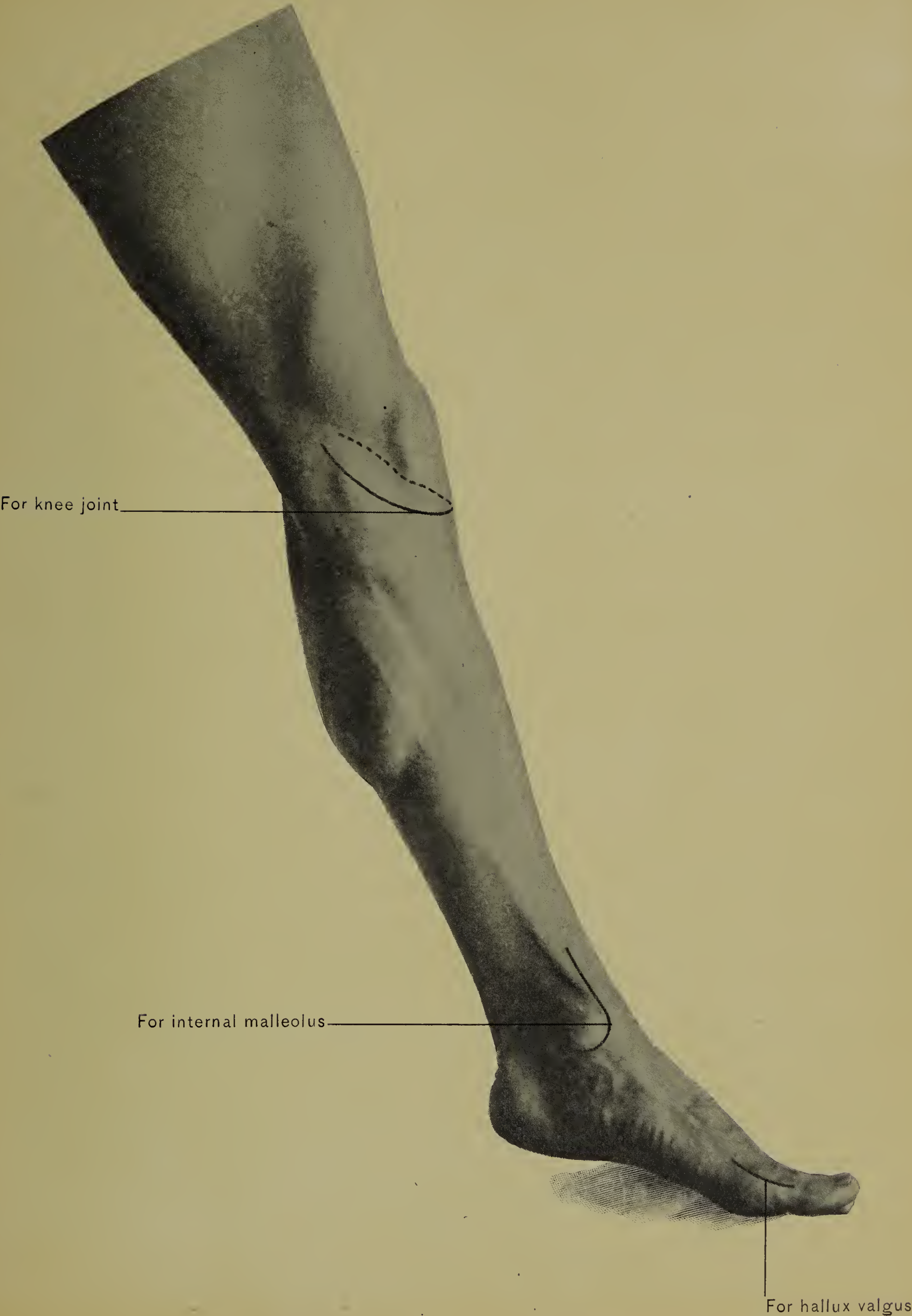
Excision of a metatarsal bone may be either complete or partial. A longitudinal incision is made over its dorsal surface through the skin and fasciæ, and the tendons displaced to one side. The periosteum is incised and separated from the bone together with the interossei muscles. The bone is then freed and removed. Care should be taken not to injure the plantar vessels and nerves.

The **metatarso-phalangeal joint of the great toe** sometimes requires excision for caries of the articular surfaces of the bones forming the joint. This is usually the result of suppuration of the synovial sac in case of "bunion." The incision should be made along the inner side of the joint.

In **excision of the phalanges** it is to be remembered that the middle phalanges of the toes should never be excised, as that would leave useless toes. The base of the first phalanx of the great toe and the terminal phalanges of the toes may be removed. The incision for excision of the terminal phalanx of the toes may be made on the plantar surface or from side to side around the end of the toes. It is best to leave the base of the phalanx behind, if possible, on account of the insertion of the extensor tendons.

DEVELOPMENT OF THE BONES OF THE LOWER EXTREMITY.

The **femur** is developed by three primary and two secondary centers of ossification. Of the primary centers the one for the shaft appears about the seventh week of fetal life. The shaft and neck of the femur are developed from this center. The center for the lower epiphysis appears about the ninth month of fetal life, it being the only epiphysis in the body in which ossification begins before birth. The condyles and tuberosities are developed from this center. The center for the head appears about the end of the first year. The secondary centers are for the two trochanters, the center for the greater trochanter appearing about the fourth year, and the one for the lesser about the fourteenth year. The union of these several centers takes place in the order opposite to that of their formation. Thus, the lesser trochanter, which is the last center to show signs of ossification, is the first to join the shaft, at about the seventeenth



LINES OF EXCISIONS.

year. This is followed by the greater trochanter and the upper epiphysis during the eighteenth year, and the lower epiphysis during the twentieth year.

The **patella** is developed from a single center of ossification which appears about the third year; ossification is not completed until the age of fourteen or fifteen.

The **tibia** is ossified from three centers, one from the shaft and one for each end. The center for the upper epiphysis appears during the first year, the union to the shaft occurring at about the twentieth year. The center for the lower epiphysis appears during the second year and joins the shaft during the eighteenth year.

The **fibula** has three centers of ossification, one for the shaft and one for each end. The center for the shaft appears during the eighth week, a little later than that for the shaft of the tibia. The center for the lower end appears about the second year, before that of the upper epiphysis. This is contrary to the general rule, that the epiphysis toward which the nutrient artery is directed is the first to ossify. It joins the shaft about the twenty-first year. The center for the upper extremity of the bone appears during the third or fourth year and joins the shaft about the twenty-fourth year.

The **tarsal bones** have one center of ossification each, with the exception of the os calcis, which always has two, and the astragalus, which may at times have two. The first center of the os calcis appears about the sixth month of fetal life; the second center appears about the tenth year and coalesces with the first about the fourteenth year. The center for the astragalus appears about the seventh month, that of the cuboid near the ninth month, that of the external cuneiform about the first year after birth, that of the middle and internal cuneiform and the scaphoid about the third or fourth year.

The **outer four metatarsal bones** have two centers of ossification, one for the shaft, which appears during the eighth or ninth week, and one for the head, which appears from the third to the eighth year. The epiphysis joins the shaft about the nineteenth year.

The **first metatarsal bone** also has two centers of ossification, but the epiphysis in this case is at the proximal extremity. At times there are two epiphyses formed, one at each end. The centers in this bone appear at about the same time as do those of the outer four metatarsals.

Each of the **phalanges** has two centers of ossification, one for the shaft and distal end, the other for the proximal end. They unite at about the twentieth year.

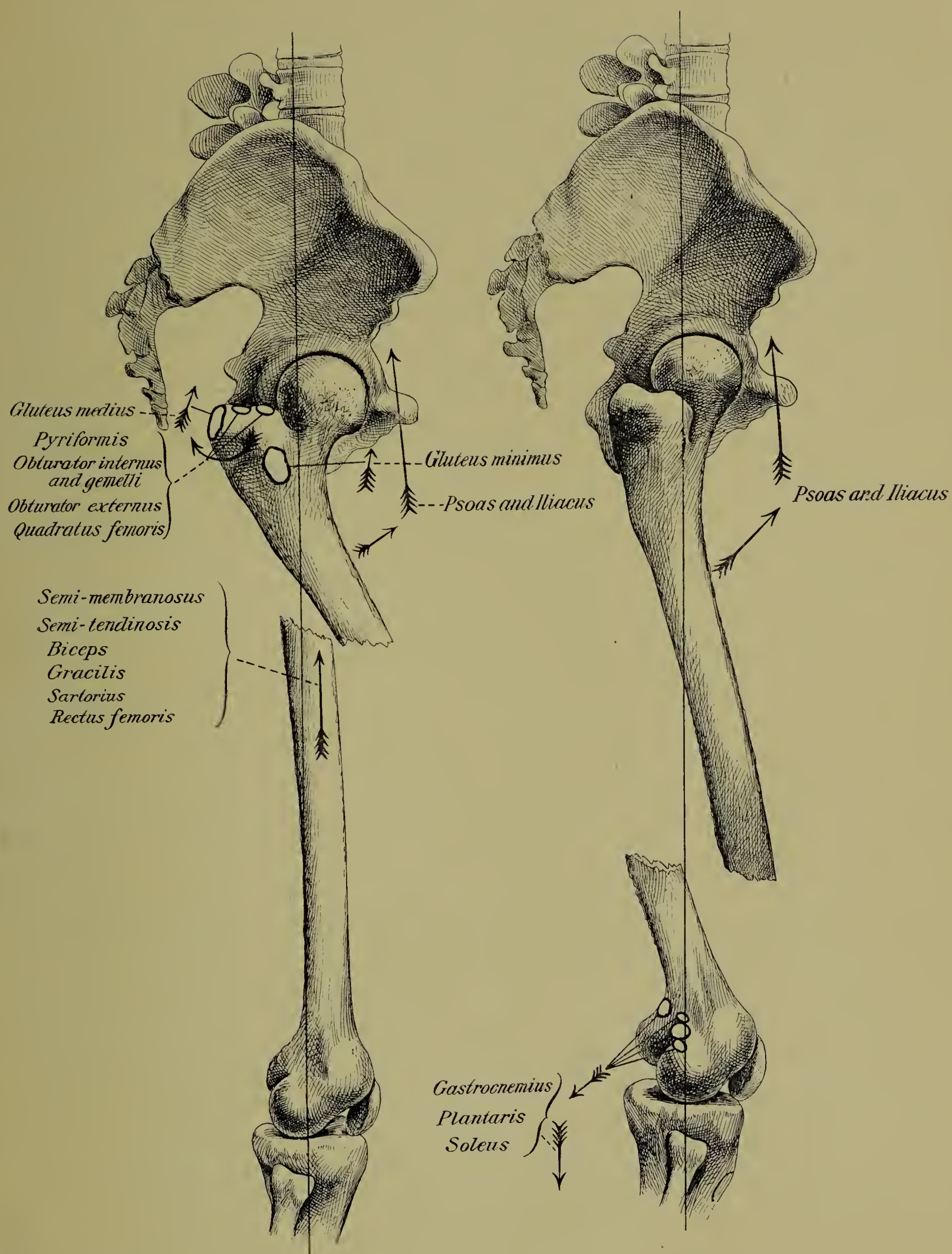
FRACTURES.

Fractures of the femur occur at the neck, throughout the shaft, and in connection with the condyles. Fractures through the neck are divided into those within the capsule, intracapsular, and those without, extracapsular; fractures through the shaft, into those of the upper, middle, and lower third; fractures of the condyles, into those affecting one or both condyles, fractures between the condyles, and fractures above the base of the condyles, or supracondylar fractures.

Intracapsular fractures are those which occur entirely within the capsule. Clinically, they are hard to diagnose positively, on account of the fact that the capsule is attached at different distances from the head of the bone, thus making it probable that part of the fracture is within, and part of it without, the capsular ligament. In this fracture the lower extremity is shortened about an inch (2.5 centimeters) at the time of fracture, the shortening, however, becoming greater after partial absorption of the neck (consecutive shortening) has occurred. At times there will be but very slight, if any, shortening, on account of the ends of the fragments being in apposition. In these cases it may be weeks before there is any appreciable shortening. The shortening is caused by the action of the glutei, the semimembranosus, the semitendinosus, the tensor fasciæ femoris, the rectus, the sartorius, the ilio-psoas, the adductor, the gracilis, and the pectineus muscles. This shortening of the limb will bring the great trochanter nearer the crest of the ilium, and thus shorten the base of Bryant's triangle, and throw the three points in Nélaton's line out of alignment, the great trochanter being above the other two points. This triangle and line have been described under the surface anatomy of the lower extremity. The action of the ilio-psoas, the external rotators, the pectineus, and the adductor muscles will tend to roll the limb outward. Owing to the displacement of the great trochanter, there will be flattening of the normal site of this process. The tensor fasciæ femoris, the ilio-tibial band, and the gluteus medius muscles will generally be relaxed. As a rule, there will be no tear of any of the ligaments of the hip-joint, although some of them may be slightly stretched.

Extracapsular fractures of the femur present about the same anatomical signs as do the intracapsular variety. The same muscles act on the two fragments, and the same changes in the base of Bryant's triangle and in Nélaton's line are noticed. If the fracture extends through the capsule, thus making the break a combination of the two varieties, there may be some laceration of the capsular ligament, and some of the accessory ligaments of the capsule.

The **great trochanter** may be severed from its connection to the shaft of the femur, generally by direct action. In this fracture the process will lie above



Nélaton's line, and the base of Bryant's triangle will be shortened. The process is drawn upward and backward by the action of the external rotators which are attached to it.

Fractures of the shaft may be divided into those of the upper, middle, and lower thirds. The highest fracture is that of the bone just below the lesser trochanter. The upper fragment is abducted and tilted upward by the psoas and iliacus which are inserted into the process, and abducted by the external rotators. The lower fragment is acted upon by the extensor muscle, the quadriceps extensor, which draws it upward and abducts it.

In fracture of the shaft of the femur the lower fragment is generally drawn upward, within or posterior to the upper fragment, which is carried anteriorly and abducted. The lower fragment is carried upward by the action of the semimembranosus, the semitendinosus, the gracilis, the rectus, the sartorius, the tensor fasciæ femoris, the adductor longus, the adductor magnus, and the vastus externus. The upper fragment is carried forward by the action of the psoas and iliacus muscles, and adducted by the external rotators of the thigh. The angle of deformity is generally marked. The limb is shortened from one to three inches (2.5 to 7.5 centimeters), depending upon the amount of the obliquity of the fracture. In fractures of the lower third there may be injury to the superficial femoral artery or vein, on account of the close proximity of these vessels to the bone in this part of their course. In the supracondylar variety the fracture is from one to two inches (2.5 to 5.0 centimeters) above the base of the condyles. The contour of the knee is lost. The lower fragment is drawn inward and backward by the action of the gastrocnemius, popliteus, and plantaris muscles, and upward by the abductor muscles. The patella is thrown forward, and often rests upon the lower end of the upper fragment, the latter being in front of the lower fragment. At times, this fracture may have a T-shape, and extend into the knee-joint. In these cases there will be marked effusion into the joint, and diagnosis of the fracture rendered more difficult.

In **fracture of either condyle** there will be little, if any, displacement of the fragments. The width of the knee-joint may be markedly increased and the general contour of the joint lost.

In **fracture of the patella** there is marked displacement of the upper fragment, as a rule, by the action of the quadriceps, which is inserted into it. The lower fragment usually retains its normal position on account of the unyielding quality of the ligamentum patellæ. There is generally a marked sulcus between the two fragments. There may be lateral displacement of the fragments through the unequal contraction of the ligaments or fibrous bands connected to the sides of the bone. Crepitus is absent, as a rule, owing to the fact that many of the

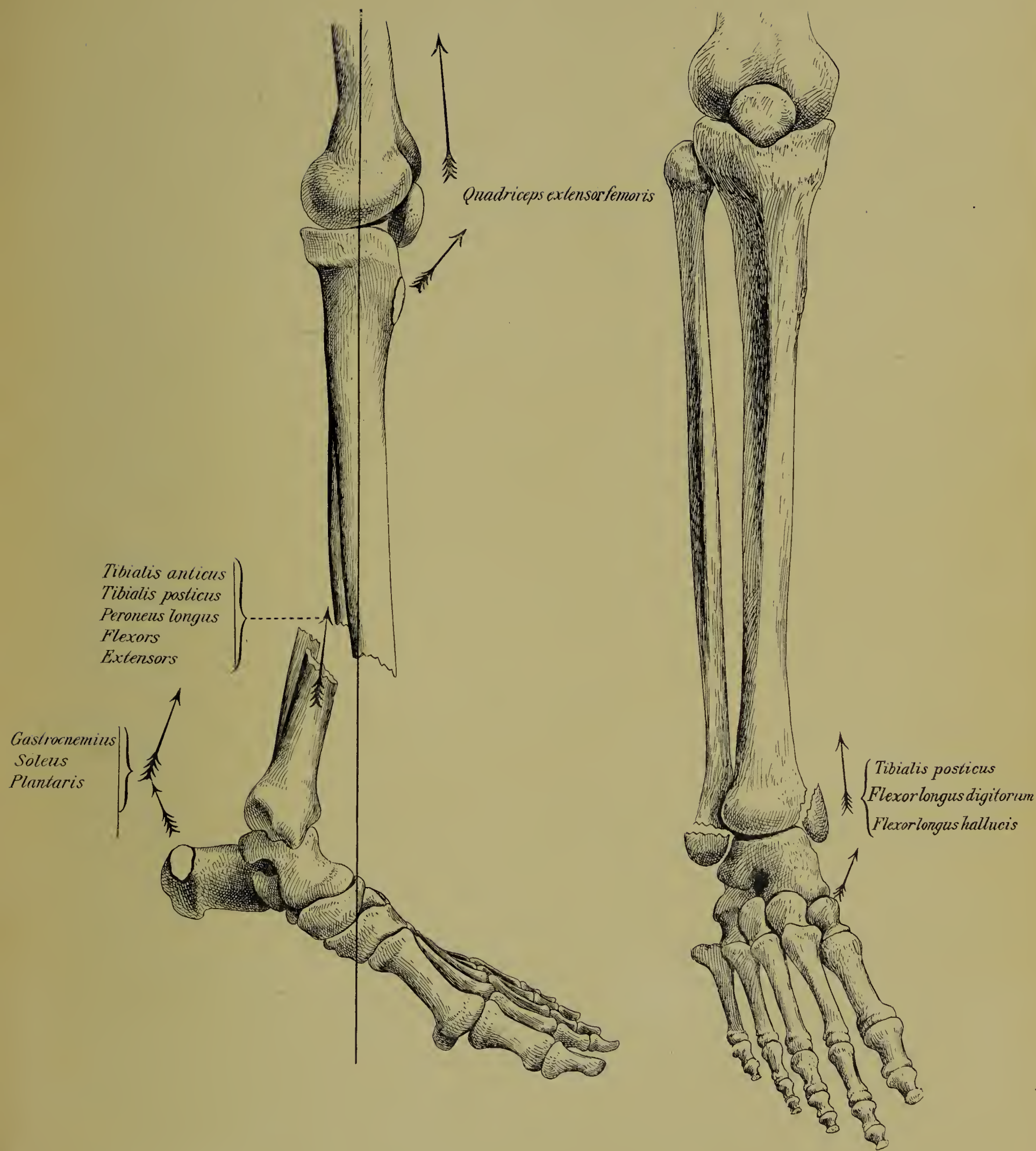
strands of the fibrous expansion of the quadriceps muscle are drawn into the fracture, thus preventing exact apposition of the fragments. This also plays an important rôle in the union which follows this fracture. The knee-joint is always opened, unless the fracture be in the lower part of the patella. The posterior surface of the bursa in front of the knee is generally lacerated, thus allowing free communication between the articular synovial capsule and the bursal cavity.

Fractures of the tibia generally occur near the junction of the lower with the middle third. The bone is smaller at this point than at any other part of the shaft, and this probably accounts for the frequency of the fracture here. As a rule, the displacement is not very marked, on account of the fact that the fibula acts as a retaining splint, and because the fracture is generally transverse. If the fracturing force be indirect, the line of fracture will generally be oblique, and we will then find displacement of the lower fragment upward and backward, by the muscles of the calf. Owing to the subcutaneous situation of the crest of the tibia, fractures of this bone are very frequently compound, or may be readily made so by careless manipulation of the fragments.

Fractures of the internal malleolus usually show but little sign of displacement of the fragment, owing to the fact that the internal lateral (deltoid) ligament, which is attached to the borders and apex of the malleolus, prevents the fragment from becoming detached. There may be slight inversion of the foot, with a small amount of lateral displacement of the fragment.

The **fibula** may be fractured at any part of its extent, although the breaks of this bone are most common in the lower part. The tibia acts as a very strong side-splint and thus protects the fibula from injury. The fractures in the middle and upper thirds cause but little displacement, on account of the presence of the tibia, and on account of the firm padding of the muscles and fascia which the fibula has. In the lower part of the fibula fracture of the bone about two or three inches (5.0 to 7.5 centimeters) above the external malleolus is quite frequent. This is known as **Pott's fracture**, and is generally complicated by laceration of the internal lateral ligament. There is almost always a partial dislocation of the ankle associated with this fracture. There is generally marked inversion of the foot owing to the laceration of the lateral ligament.

The **external malleolus** may be fractured, but there will be little, if any, displacement, unless the external lateral ligament be torn. This is the most frequent seat of *sprained fracture*, the external lateral ligament tearing off the portion of the external malleolus to which it is attached. In the majority of so-called "sprained ankles" this is the true condition of affairs as demonstrated by X-ray examination in a large number of cases studied at the German Hospital of Philadelphia.



(A) FRACTURE OF BOTH BONES OF THE LEG.

(B) FRACTURE OF BOTH MALLEOLI.

Fractures of both bones of the leg are more common than a fracture of either one separately. The displacement is generally in the line of the fracturing force.

In **fractures of the astragalus** the break usually occurs at the neck of the bone, as this is the weakest part of it. There is but little, if any, displacement, as there are no muscular attachments to produce it.

Fractures of the calcaneum are generally due to direct violence. If the break be anterior to the attachment of the strong calcaneo-astragaloid ligaments, there will be but little displacement; if behind these ligaments, the posterior fragment will be drawn upward by the action of the calf muscles which are inserted into the bone through the tendo Achillis, thus making a marked deformity. The dense fibrous tissue around the bone helps to prevent marked displacement.

Fractures of the tarsus do not show marked displacement, on account of their intimate relation one with the other, and the firm ligaments which tend to hold them in place.

In **fracture of the metatarsal bones** the displacement is always slight, and generally in the line of the breaking force. Sprained fracture of the overlapping process of the fifth metatarsal bone at its articulation with the cuboid is not infrequent.

In **fracture of the phalanges** there is but little or no displacement.

AMPUTATIONS.

The methods of amputations have been described with the amputations of the upper extremities.

Amputations of the Foot.—The principal amputations of the foot are the disarticulation at the interphalangeal joints; the disarticulation at the metatarso-phalangeal joints; Lisfranc's amputation, or the disarticulation at the tarso-metatarsal joint; Chopart's amputation, or the disarticulation at the medio-tarsal joint; Symes' amputation, or disarticulation of the entire foot at the joint formed by the tibia, fibula, and astragalus; and Pirogoff's amputation, a modification of Symes' amputation in which part of the calcaneum is retained. The foot, however, or any part of it, can be amputated without regard for the several joints, the foot being considered as a solid whole.

In **amputation of the phalanges of the toes** the portion of the member to be removed is generally disarticulated at the joint to the proximal side of the injury or disease. In removing any of the toes, with the exception of the great toe, it is considered advisable to remove the entire member at the metatarso-phalangeal articulation, as the stump remaining after an amputation in the continuity of the

phalanx, or at any of the phalangeal joints, is often very troublesome and of very little use to the possessor.

In *disarticulating the distal phalanx* of any of the toes an incision is carried along the lateral aspect of the same from the level of the joint, around the end of the toe to a point directly opposite the beginning of the incision on the other side. The two ends of the incision are then joined by a dorsal incision. The incision should reach the bone in its entire extent. The lateral incision should be made nearer the dorsal than the plantar surface in order to avoid injuring the plantar digital arteries. The lateral incision severs skin and superficial fascia and the pad of connective tissue over the end of the toe. The dorsal incision goes through the skin and superficial fascia, divides the tendon of the extensor longus digitorum in the outer four toes and of the extensor proprius pollicis in the great toe. The arteries severed are as follows: branches of the second, third, and fourth dorsal interosseous arteries in the outer three toes and in the outer side of the second toe; branches of the dorsalis hallucis on the inner side of the second and outer side of the great toe; and the dorsal digital artery on the inner side of the great toe. The nerves are branches of the external saphenous and musculo-cutaneous nerves. The dorsal incision should open the joint. The lateral and glenoid ligaments are then divided and the bone removed. If care has been exercised in making the plantar flaps by keeping close to the bone, the plantar digital arteries will not be severed. They will be found in the lower flap, near the junction of the lateral and dorsal incisions.

In *disarticulating at the first interphalangeal joint* the incision is begun on the dorsal surface of the toe, just above the joint, and carried over the joint to a point about one-half inch (1.25 centimeters) below it. From there the incision is prolonged around the sides of the toe to the end of the dorsal incision. This incision will divide the skin and superficial fascia, with twigs from the collateral branches of the musculo-cutaneous and external saphenous nerves on the dorsum and sides of the toes, and of the internal and external plantar nerves on the plantar surface; the plantar digital and the interosseous branches of the first, second, third, and fourth interosseous arteries; the tendons of the flexor brevis digitorum and flexor longus digitorum and the flexor longus hallucis in the great toe on the plantar surface; the extensor longus and brevis digitorum, and, in the great toe, the extensor proprius pollicis on the dorsal surface. The bone is then freed by dividing the external and internal lateral and glenoid ligaments.

In *disarticulating the toes at the metatarso-phalangeal joint* the incision is made over the dorsal aspect of the joint, with lateral incisions extending to the plantar surface. In the great toe the incision should be carried well forward in order

to afford sufficient tissue to cover in the large extremity of the metatarsal bone. The end of the metatarsal bone should never be removed unless absolutely necessary, as the entire bone is needed for the support of the foot. In all the toes the skin and superficial fascia are divided, with twigs of collateral branches of the external saphenous and musculo-cutaneous nerves on the dorsum of the toes, and of the internal and external plantar nerves on the plantar surface; and the plantar, digital, and interosseous arteries. The tendons of the flexor brevis digitorum and flexor longus digitorum and the lumbricales will be divided on the plantar surface of the outer four toes, and the extensor brevis digitorum and extensor longus digitorum on the dorsal aspect of the same. The lumbricales will be severed near their attachment to the inner surface of the base of the outer four toes; the plantar interossei, near their attachment to the inner surface of the bases of the outer three toes; and the dorsal interossei, near their attachment to the outer side of the bases of the second, third, and fourth toes, and inner surface of the base of the second toe. The flexor brevis hallucis, the flexor longus hallucis, and the extensor longus hallucis are divided in removing the great toe. The lateral and glenoid ligaments are then severed. In removing all the toes at one time, a dorsal incision is made from the outer to the inner border of the bases of the phalanges, on a level with the free margin of the web. The joints are opened separately from the dorsal side, and the phalanges disarticulated separately. A plantar flap is then made by cutting along the plantar surface of the phalanges. The same structures are divided as described above.

Before taking up the amputation of the foot and ankle, it may be well to enumerate the articulations of the separate bones. The metatarsal bones articulate with the internal, middle, and external cuneiform and cuboid bones. The line of the articulations is very irregular. Thus, the internal cuneiform bone projects beyond the middle cuneiform, as does the external, but not to the same extent, a mortise being formed for the articulation of the second metatarsal. The cuboid also recedes. The internal cuneiform bone receives the base of the first metatarsal, and articulates with the inner side of the end of the second metatarsal. The middle cuneiform receives the second metatarsal, and the external cuneiform the third metatarsal. The cuboid receives both the fourth and fifth metatarsal bones. The second metatarsal bone is fitted into the mortise formed by the internal and external cuneiform bones. The fifth metatarsal bone does not articulate with the cuboid by its entire surface, the outer end projecting outward in the form of a tuberosity. The three cuneiform bones articulate with the scaphoid by their proximal ends, and the scaphoid with the astragalus, by its proximal end. The cuboid articulates with the calcaneum by its proximal end, and with the external cuneiform by its internal surface, this surface at times articulating also

with the scaphoid. The line of articulation between the astragalus and scaphoid and the calcaneum and cuboid is practically a straight one. The astragalus rests upon the calcaneum, articulating with that bone and the scaphoid of the tarsus, and with the tibia and fibula of the leg. The calcaneum articulates with the astragalus and the cuboid.

Lisfranc's amputation consists in a disarticulation of the foot at the tarso-metatarsal joint. The dorsal incision begins on the outer side of the foot just above the tuberosity of the fifth metatarsal, is carried along this edge for about an inch (2.5 centimeters), then across the dorsum of the foot with a gentle downward curve to the base of the first metatarsal, and then along the inner edge of the foot for about an inch (2.5 centimeters). The flap, consisting only of skin and subcutaneous tissue, is dissected back for about an inch (2.5 centimeters); the tendons are then cut across transversely, and all the soft tissues down to the bones are dissected up to beyond the tarso-metatarsal articulation. The plantar flap is then made. This begins at the end of the dorsal incision just above the tuberosity of the fifth metatarsal and is carried along the outer edge of the foot to the level of the metatarso-phalangeal joint; then across the sole of the foot, on a line with the heads of the other metatarsal bones, to the metatarso-phalangeal articulation of the first toe; then along the inner side of the foot to the inner end of the dorsal incision. A flap of skin and subcutaneous tissue is dissected up for about an inch (2.5 centimeters) and then all the soft parts are divided down to the bone, and the flap, consisting of all the soft parts, is dissected up to above the tarso-metatarsal articulation. The structures divided on the dorsal aspect of the foot are the skin and superficial fascia, the four dorsal interossei arteries with their veins, and branches of the musculo-cutaneous and external saphenous nerves, the deep fascia, the tendons of the flexor brevis digitorum, the flexor longus digitorum, extensor proprius hallucis, and the dorsal interossei muscles. The structures divided by the plantar incision are the skin and superficial fascia, twigs from the plantar arteries and nerves, the plantar fascia, the digital branches of the internal and external plantar arteries, the internal and external plantar nerves, the tendons of the flexor brevis digitorum, the lumbricales, and the abductor minimi digiti muscles. The peroneus tertius and tibialis anticus tendons are not severed in making the incisions. The bones are then disarticulated from the dorsal surface, beginning at the fifth metatarsal. The dorsal and interosseous ligaments are divided between the outer three metatarsal and the cuboid and external cuneiform bones. In dividing these ligaments and separating the bones, the tendons of the peroneus longus and peroneus brevis muscles will be severed. The first metatarsal bone is then disarticulated from the internal cuneiform, and the expansion of the tibialis anticus tendon severed. There remains but the second metatarsal articulation to

be divided. As the second metatarsal bone fits in the mortise between the internal and external cuneiform bones, there is often great difficulty experienced in separating the bones. It is first disarticulated from the middle cuneiform, and then from the internal and external cuneiform. The peroneus longus tendon is then divided, and the foot is free.

The arteries to be tied in the dorsal flap are the four interossei which will be found over the interosseous spaces. In the plantar flap the arteries to be tied are branches of the internal and external plantar, and at times these vessels themselves.

In this amputation the plantar flap may be made by transfixion, but it is not as advisable as the method described, as the tarso-metatarsal articulation must be separated before the plantar flap is made, and because there is great danger of wounding the soft parts of the sole of the foot, and especially the plantar arteries. When performing the operation in this manner, the dorsal incision is first made, and the metatarsal bones disarticulated from the tarsal. The point of the knife is forced between the bones and worked backward and forward until the ligaments are severed. During this procedure great care must be exercised not to injure the soft parts of the sole, and especially the plantar arteries, a thing that is very liable to happen if the point of the knife be forced too far, or if it should accidentally slip. After the bones have been disarticulated, the foot is sharply flexed, and the plantar flap made by carrying the knife downward in close relation to the plantar surface of the bones.

Hey's operation is practically the same as that of Lisfranc, differing only in the fact that Hey first removed the outer four toes by disarticulating their metatarsal bones from the tarsal attachments, and then removed the projecting end of the internal cuneiform bone with the saw, the end of the bone carrying the metatarsal bone of the great toe with it. The structures divided are the same as those in a Lisfranc amputation, with this exception.

Chopart's amputation is a disarticulation of the foot at the mid-tarsal joint. This joint is practically double, being formed by the articulation of the calcaneum with the cuboid, and the astragalus with the scaphoid. These two articulations have separate synovial membranes and separate ligaments. They are practically on the same line, although the astragalo-scaphoid articulation is slightly in advance of the calcaneo-cuboid. In performing Chopart's amputation the incisions used are of the same shape as those in the amputation by Lisfranc's method. The dorsal flap begins on the outer side at a point midway between the tip of the external malleolus and the tuberosity of the fifth metatarsal bone. It is carried along the outer edge of the foot for a short distance and then over the dorsum of the foot in a slight curve on a level with the bases of the metatarsal bones.

Having reached the inner side of the foot, it is carried along the edge of the same to a point just behind the tuberosity of the scaphoid. The plantar flap is made by carrying an incision across the sole of the foot at the middle of the metatarsal bones. The flaps consist of all the soft parts down to the bone. They are dissected up as far as the mid-tarsal articulation, which is fully exposed. The calcaneum is then disarticulated from the cuboid by severing the internal calcaneo-cuboid, the dorsal calcaneo-cuboid, and the long and short plantar ligaments; the astragalus is then to be separated from the scaphoid by dividing the astragalo-scaphoid and the inferior and external calcaneo-scaphoid ligaments. The structures severed, with the exception of the ligaments and the tendon of the *tibialis posticus*, are the same as those in the Lisfranc amputation.

The vessels that require ligation in the dorsal flap are the *dorsalis pedis* and its tarsal and metatarsal branches. In the plantar flap the internal plantar artery will be divided in the inner portion, the external plantar on a level with the second metatarsal bone, and the digital branches of the external plantar in the outer portion of the flap.

Symes' amputation consists in the disarticulation of the astragalus from the tibia and fibula, and the removal of the articulating surface of the tibia together with the internal and external malleoli. The first incision starts at the tip of the external malleolus and is carried, at right angles to the long axis of the foot, across the heel and vertically up the inner side of the foot to a point just below the tip of the internal malleolus. It is often advisable to carry the first part of the incision across the heel and then start again at the internal malleolus and carry an incision downward to meet the end of the first. In this way the possibility of carrying the incision too high on the inner side of the foot is prevented. The main objection to this operation is that the blood supply of the heel-flap is liable to be deficient, thus causing subsequent sloughing. This may be avoided to a great extent by carrying the incision across the sole of the foot a little anterior to the long axis of the tibia (Wyeth). The incision severs all structures down to the bone. The flap is then carefully carried backward, the knife hugging the bone in order to avoid injuring the branches of the posterior tibial near its bifurcation. The calcaneum is stripped of all its soft parts. The dorsal incision is then made by joining the ends of the plantar incision directly across the front of the ankle. This incision severs all the soft parts down to the bone, and severs the anterior ligament of the ankle-joint. The external lateral ligament is then divided, then the internal and posterior, and finally the *tendo Achillis*, and the foot is removed. The soft parts are then cleaned from the two malleoli and the lower end of the tibia. In doing this, care should be exercised not to injure the flaps. The ends of the tibia and fibula are then removed with

a saw, in a horizontal cut, a small portion of the cartilage covering the tarsal end of the tibia being removed with the malleoli.

The parts divided by the plantar incision include the skin and superficial fascia, twigs from the musculo-cutaneous, short saphenous, and internal calcanean nerves, branches of the external calcanean and the internal and external plantar arteries, the deep fascia, the external saphenous vein, the internal malleolar and external malleolar branches of the anterior tibial artery, the tendons of the peroneus longus and brevis, and of the flexor longus hallucis muscle, the plantar fascia, and the origins of the abductor hallucis, flexor brevis digitorum, and abductor minimi digiti muscles. The posterior tibial artery divides into the internal and external plantar arteries "on a level with a line drawn from the point of the internal malleolus to the center of the convexity of the heel." This point is very near the line of incision, and the branches of the posterior tibial, or even that vessel itself, may at times be divided. The dorsal incision divides skin, superficial fascia, twigs of the musculo-cutaneous and saphenous nerves, the internal saphenous vein, the musculo-cutaneous nerve, the deep fascia, the tendons of the peroneus tertius, extensor longus digitorum, tibialis posticus, and flexor longus digitorum muscles, the anterior peroneal and anterior tibial vessels, and the anterior tibial nerve.

The vessels that will require a ligature are the anterior tibial, which will be found in the center of the dorsal incision; the internal and external plantar, in the inner part of the heel-flap; the internal malleolar branch of the posterior tibial, behind the internal malleolus; the anterior peroneal in front of the tibio-fibular joint; and the internal and external malleolar branches of the anterior tibial.

In **Pirogoff's amputation** the same incisions are used as those in Symes', with the exception that the plantar flap is carried more anteriorly. The plantar flap is dissected from the calcaneum for but a quarter of an inch (0.6 centimeters), and the dorsal flap is then made. The joint is opened and the astragalus carried forward from its position between the two malleoli. A fine saw is applied to the calcaneum just behind the posterior lip of the astragalus and the bone sawed through in a forward and downward direction. After the malleoli have been removed as in Symes' amputation, and the vessels secured, the remaining portion of the calcaneum is brought into apposition with the ends of the tibia and fibula and held in place with silver wire. The other structures divided are the same as in the Symes' operation.

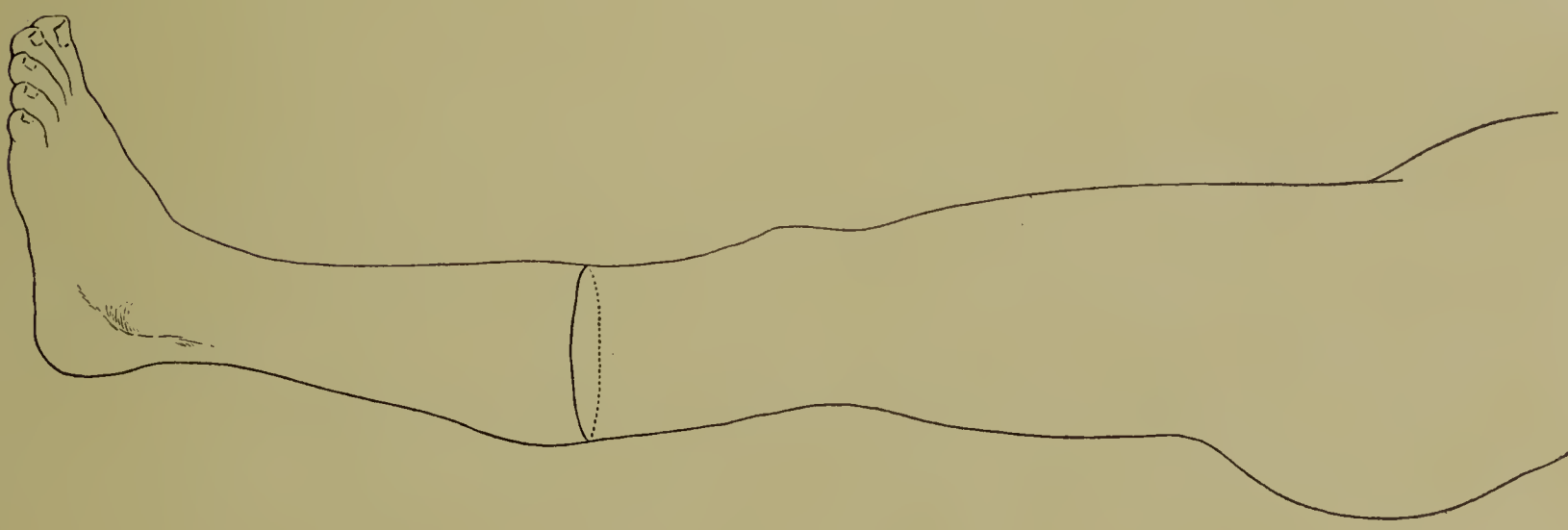
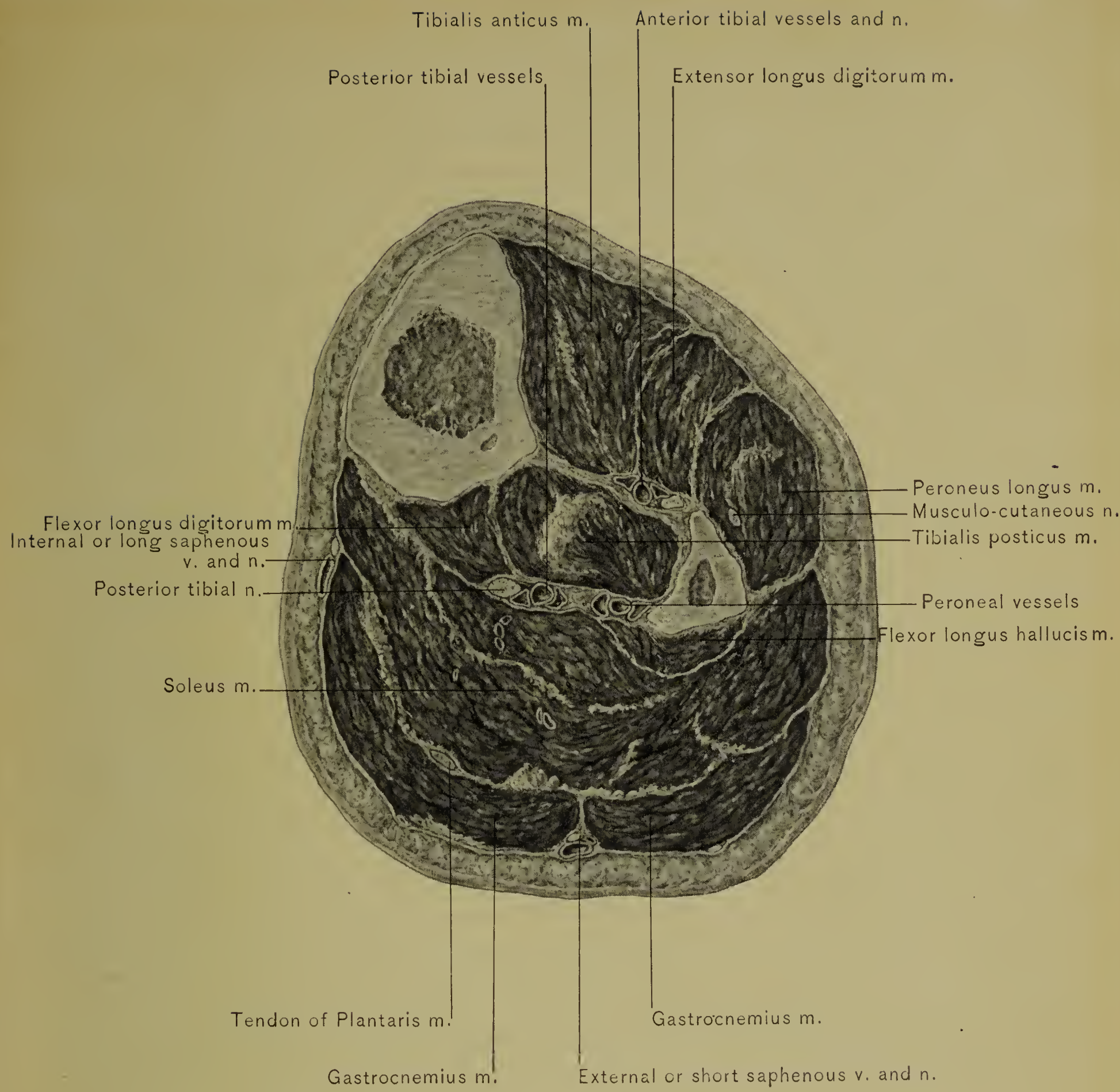
Amputation of the Leg.—*Antero-posterior flap method:* The incision is started on the inner side of the leg about an inch (2.5 centimeters) below the point at which the bones are to be divided. It is carried downward along the inner side of the leg for a sufficient distance to furnish enough flap, and then

across the back of the leg to the middle of the outer side. The outer longitudinal incision is then made. It should commence at a point on a level with the beginning of the first incision and complete the posterior flap. The anterior flap is made by carrying an incision across the front of the leg, with a slight downward curve. These incisions sever only the skin and superficial fascia. The flaps consisting of skin and fasciæ are dissected up and the muscles and vessels cut transversely by a circular incision. The bones are then sawed through, the fibula first, after the soft parts have been well cleaned from them.

The anterior incision will divide, in the middle of the leg, the skin and superficial fascia, with the internal saphenous nerve and vein, twigs from the internal saphenous and the communicans peronei nerves, and small branches of the anterior tibial artery. The posterior incision divides the skin and superficial fascia with the external saphenous nerve and vein, the cutaneous branch of the external popliteal nerve, and branches of the popliteal artery. The circular incision divides the deep fascia, the tibialis anticus, the extensor longus digitorum, and the extensor proprius hallucis muscles, the anterior tibial vessels, and the anterior tibial nerve on the anterior aspect of the leg; the flexor longus digitorum, tibialis posticus, soleus, and gastrocnemius muscles, the posterior tibial vessels, the posterior tibial nerve, and the peroneal vessels on the posterior aspect; and the peronei muscles on the outer aspect.

The main vessels to be tied are the anterior tibial artery, which is found between the tibialis anticus and extensor proprius hallucis muscles, lying on the anterior surface of the interosseous membrane; the posterior tibial, which is found beneath the flexor longus digitorum muscle in the posterior part of the leg; and the peroneal artery, which is found beneath the tibialis posticus, just to the tibial side of the fibula. Modifications in making the flaps and dividing the muscles are numerous. Among them may be mentioned Teale's, which consists of a long anterior rectangular, and a short posterior rectangular flap, both flaps containing all the tissues down to the bone. Lee's amputation is very similar to that devised by Teale, with the exception that the long flap is made on the posterior, and the short one on the anterior surface of the leg. Lateral flaps are also often advised. In Teale's and Lee's flaps the soft parts are divided on a level with the skin incision. Hey advised severing the gastrocnemius muscle first, and then making two lateral incisions to the bone, in the line of the skin incision. The muscles must then be separated from the bone and severed by cutting them from within outward, thus making the flaps musculo-tegumentary.

Amputation at the Knee-joint.—*Antero-posterior flap method*: The incision begins on a level with the posterior border of the condyle of the femur, a little below its tuberosity. If started above this point, there will be danger of cutting



AMPUTATION OF LEG, UPPER THIRD.

the fascial and fibrous tissues which hold the attachments of the strong muscles of the thigh. The incision is carried down the leg to a point about on a level with the tubercle of the tibia, and then across the front of the leg with a slight downward curve to the opposite side, and then up this side of the leg to a point opposite the beginning of the incision on the other side. The flap contains the skin and superficial fascia. It is dissected up as far as the tubercle of the tibia, and the leg then flexed in order to tighten the ligamentum patellæ, which is divided. The capsule of the joint is opened and the anterior flap turned upward. The lateral and crucial ligaments are divided, but the ligamentum mucosum is allowed to remain to afford additional strength to the anterior flap. In dividing the ligaments care must be taken to prevent the knife injuring the vessels in the popliteal space. The knife is then passed between the tibia and femur, close to the tibia, and a posterior flap made by cutting downward and outward.

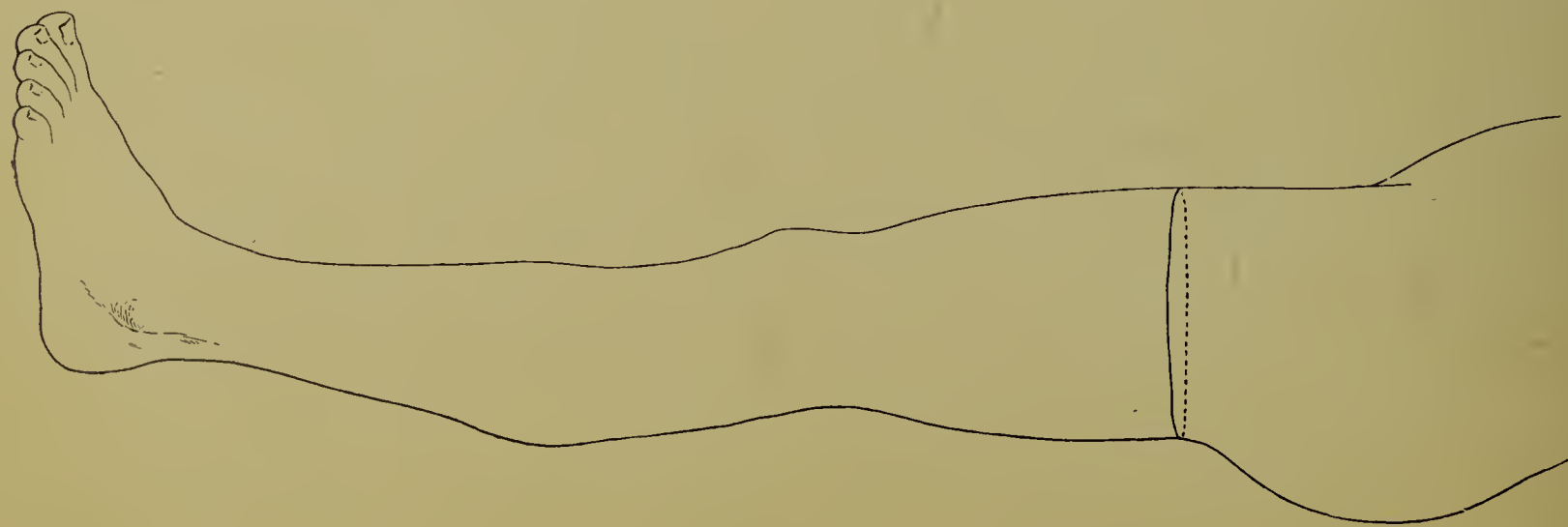
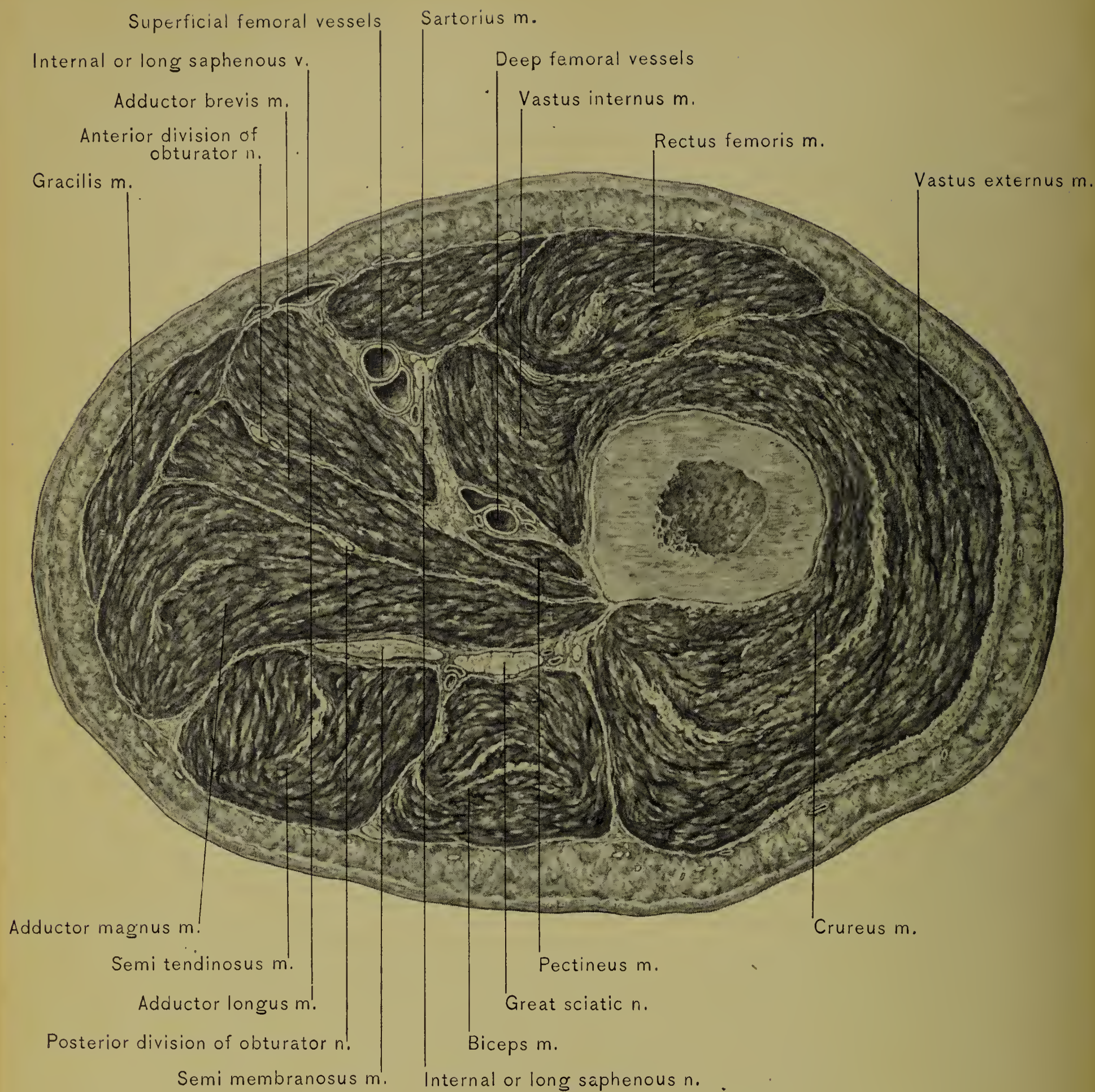
The anterior incision divides the skin and superficial fascia, the patellar plexus of nerves and superficial branches of the arterial plexus, the deep fascia, the ligamentum patellæ and the capsule of the knee-joint; the long saphenous vein and nerve, near the inner angle of the flap; and near either condyle the anastomotic and the two superior articular arteries. The posterior incision divides the skin and superficial fascia, with twigs of the internal saphenous nerve and vein, the communicans peronei and the communicans poplitei nerves, small branches of the popliteal, anastomotic, and articular arteries, the deep fascia, the small sciatic nerve, the sartorius, the gracilis, the semimembranosus, the semitendinosus, the popliteus, the plantaris, the biceps, and both heads of the gastrocnemius, the popliteal artery, the popliteal vein, and the internal and external popliteal nerves. The arteries requiring ligation will be the popliteal, which will be found near the center of the posterior flap, the anastomotica magna, and the superior articular.

Amputation of the Thigh may be performed by one of the several methods advised. In the circular method the incision is to be made a sufficient distance below the point at which the bone is to be divided to allow of enough flap material to cover the end of the stump. As the muscles of the thigh contract unequally, the incision should be made at right angles to the long axis of the limb, but with a gentle slope from above downward and before backward. The flap is to be carried upward to the level at which the limb is to be amputated and the soft tissues are then divided at right angles to the bone at this point. The muscles and vessels are protected by a cloth retractor, and the bone sawed through. If desirable, after making the circular incision through the skin, the latter may be allowed to retract and the muscles then severed at right angles to the bone at the

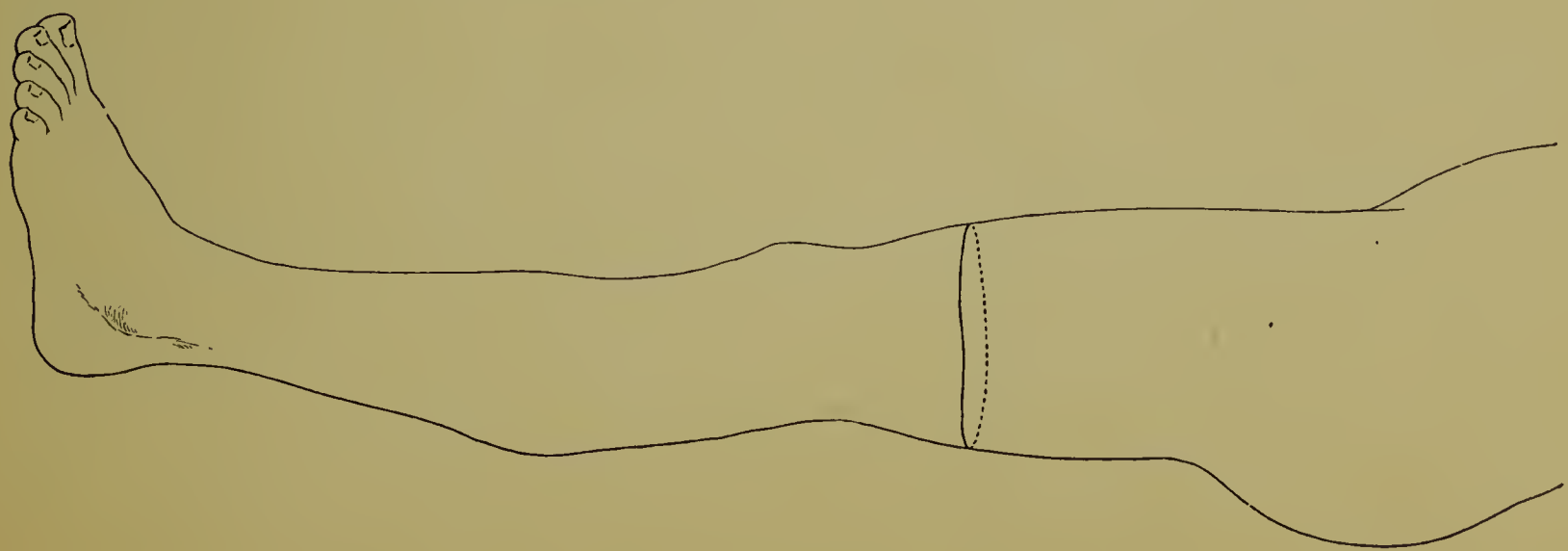
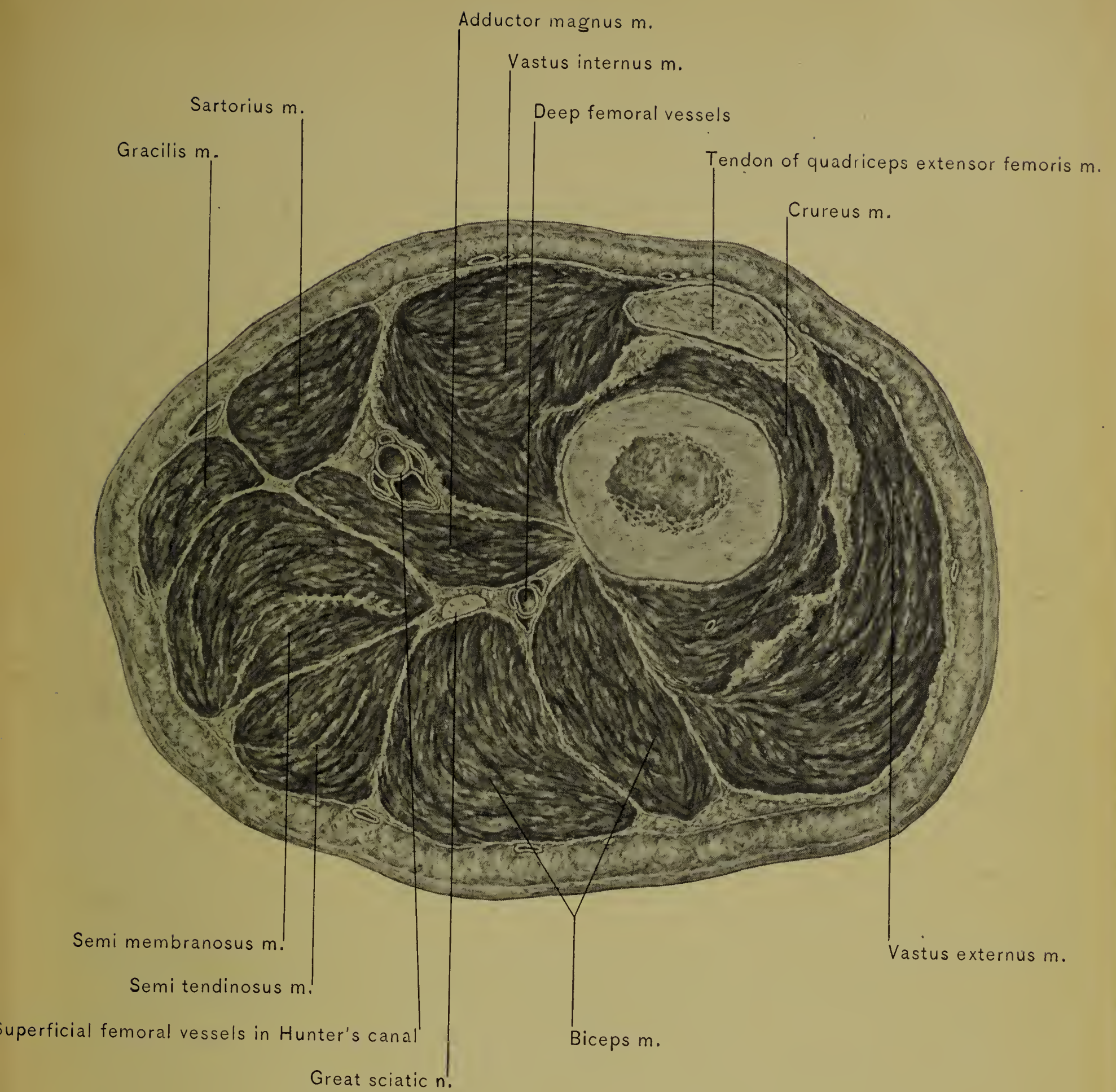
margin of the retracted skin. Two lateral incisions are then to be made down to the bone and the soft parts separated from it, and then lifted from the bone in the form of anterior and posterior solid flaps, and the bone divided.

The parts divided by the circular incision through the skin and superficial fascia are the middle cutaneous, the internal cutaneous, and the external cutaneous nerves, the crural branch of the genito-crural nerve, and the internal saphenous vein. The circular incision through the soft parts divides the fascia lata, the quadriceps femoris, sartorius, gracilis, adductor longus, adductor magnus, semimembranosus, semitendinosus, and biceps muscles; the superficial femoral, the deep femoral, the lower perforating, and the descending branch of the external circumflex arteries; the obturator, the great sciatic, and the small sciatic nerves. The main vessels to be ligated will be the superficial femoral artery and vein, the deep femoral artery and vein, and the descending branch of the external circumflex artery. The superficial femoral artery will be found on the inner aspect of the thigh in the triangular space between the sartorius, internally, the vastus internus, anteriorly, and the adductor longus, posteriorly. The vein will be found to its inner side. The deep femoral will be found immediately behind the femur, between the crureus and adductor magnus muscles. The descending branch of the external circumflex will be found on the external aspect of the stump, lying on the sheath of the crureus muscle.

Amputation at the Hip-joint.—The main difficulty experienced in performing this operation is the prevention of hemorrhage from the femoral artery and its large branches. Many ways have been suggested by which this difficulty may be overcome, among them being the ligation of the femoral or external iliac artery before the flap has been made; ligation of the femoral at the edge of the flap before dividing the artery; compression of the artery as it passes over the brim of the pelvis; compression of the external iliac artery; compression of all the blood supply by a rubber band, etc. Wyeth has advised the use of two long mattress needles, by which the rubber band is retained in place and all possibility of the band slipping and freeing the vessels is prevented. “Two steel mattress needles, three-sixteenths of an inch (0.45 centimeters) in diameter and a foot long are used. The point of one is inserted an inch and a half (3.75 centimeters) below, and just to the inner side of, the anterior superior spine, and is made to traverse the muscles, passing about half-way between the great trochanter and the iliac spine, external to the neck of the femur, and coming out just behind the trochanter. The point of the second needle is entered an inch (2.5 centimeters) below the level of the groin internal to the saphenous opening, and, passing through the adductors, comes out about an inch and a half (3.75 centimeters) in front of the tuber ischii. No vessels are endangered by these



AMPUTATION AT THE UPPER THIRD OF THE THIGH.



AMPUTATION AT THE LOWER THIRD OF THE THIGH.

needles. The points are protected by corks, to prevent injury to the operator's hands."

The strong rubber tube is then wrapped firmly around the limb above the needles and firmly tied, and the limb removed by the circular method.

External Racket Incision.—With the limb adducted and rotated inward, the point of the knife is introduced above the upper edge of the great trochanter and is carried vertically down the thigh for about six or seven inches (15.0 or 17.5 centimeters). The incision is then carried around the thigh, in front and behind, in two parts which meet on the inner side of the thigh. This incision divides the skin and superficial fascia, the external, middle, and internal cutaneous nerves, anteriorly; and the small sciatic, posteriorly; the long saphenous vein, and numerous branches of the posterior femoral cutaneous vein; branches of the obturator and gluteal arteries, and of the internal and external circumflex. The skin and subcutaneous tissues are then to be dissected up in the form of a flap for about two inches (5.0 centimeters), and the vertical incision carried down to the bone. The muscles attached to the femur are divided, the capsule opened, the round ligament divided, and the head of the bone disarticulated. The muscles to be separated from the femur include the gluteus maximus, medius, and minimus, the gemellus superior and inferior, the obturator internus and externus, the piriformis, the psoas, the iliacus, the pectineus, the adductor magnus, and the adductor brevis. Having thoroughly cleared the upper part of the femur of the muscular attachments, the capsule is to be freely opened by a vertical incision. The thigh is rotated outward and the round ligament divided. The remaining muscles are then divided by a circular cut at the level of the retracted skin. This incision divides the fascia lata and the ilio-tibial band, the tensor vaginæ femoris, the rectus, the sartorius, the gracilis, the adductor longus, the semimembranosus, the semitendinosus, and the biceps muscles, the superficial femoral artery and vein, the deep femoral artery and vein, the internal and external circumflex arteries, and branches of the gluteal, obturator, and sciatic arteries. The great sciatic nerve, the anterior crural nerve, and numerous muscular twigs from these nerves will also be divided.

The femoral vessels will be found near the center of the anterior part of the flap, in the following order from without inward: superficial femoral artery, superficial femoral vein, deep femoral vein, deep femoral artery. The internal circumflex artery will be found near the inner and posterior side of the acetabulum. The external circumflex may not be divided, but its descending branch will be, near the inner edge of the vastus externus.

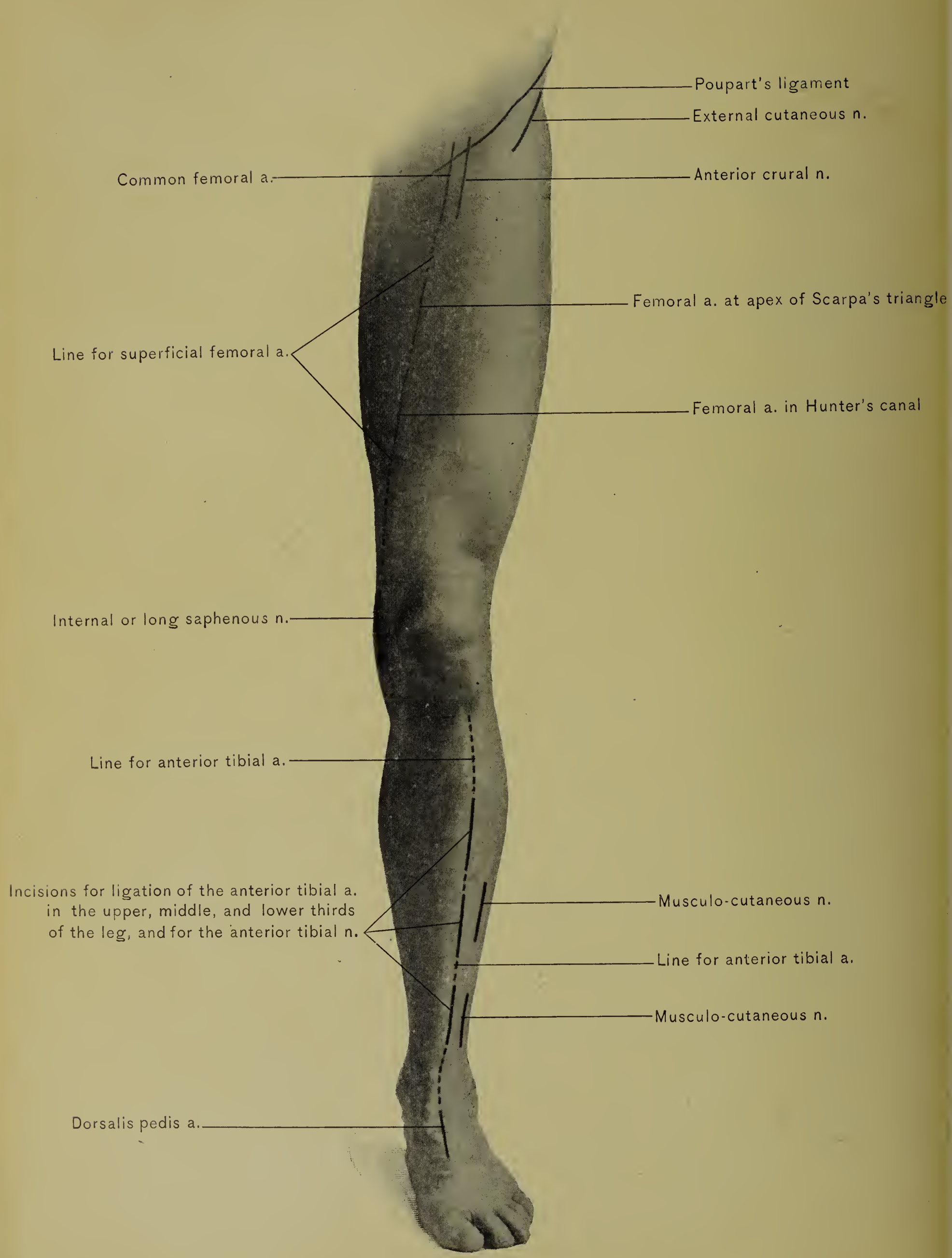
In removing the lower extremity at the hip-joint by the transfixion method,

no tourniquet or rubber band is applied. The point of the knife is introduced at a point midway between the anterior superior iliac spine and the top of the great trochanter, and is then thrust through the limb parallel with Poupart's ligament and brought out on the inner side of the thigh at a point about one inch (2.5 centimeters) in front of, and an inch (2.5 centimeters) below, the tuber ischii. Being passed as deeply as possible, the knife grazes the head of the femur and opens the capsule of the joint. The anterior flap is then to be cut by carrying the knife downward for about seven or eight inches (17.5 or 20.0 centimeters), and then forward through the intervening structures. As soon as an assistant is able to pass his fingers through the wound he should do so, and compress the main vessels of the anterior flap, as is done in the amputation at the shoulder-joint, with the exception that the thumbs are on the skin in the thigh, and against the vessels in the arm. The capsule is then thoroughly opened, the limb rotated outward, and the round ligament divided. The assistant still retains the pressure on the anterior vessels and holds the anterior flap out of the way of the operator. The posterior flap is then to be formed by carrying the knife behind the head of the femur and the great trochanter, downward and outward. The internal circumflex artery should then be tied at once, and after that the femoral.

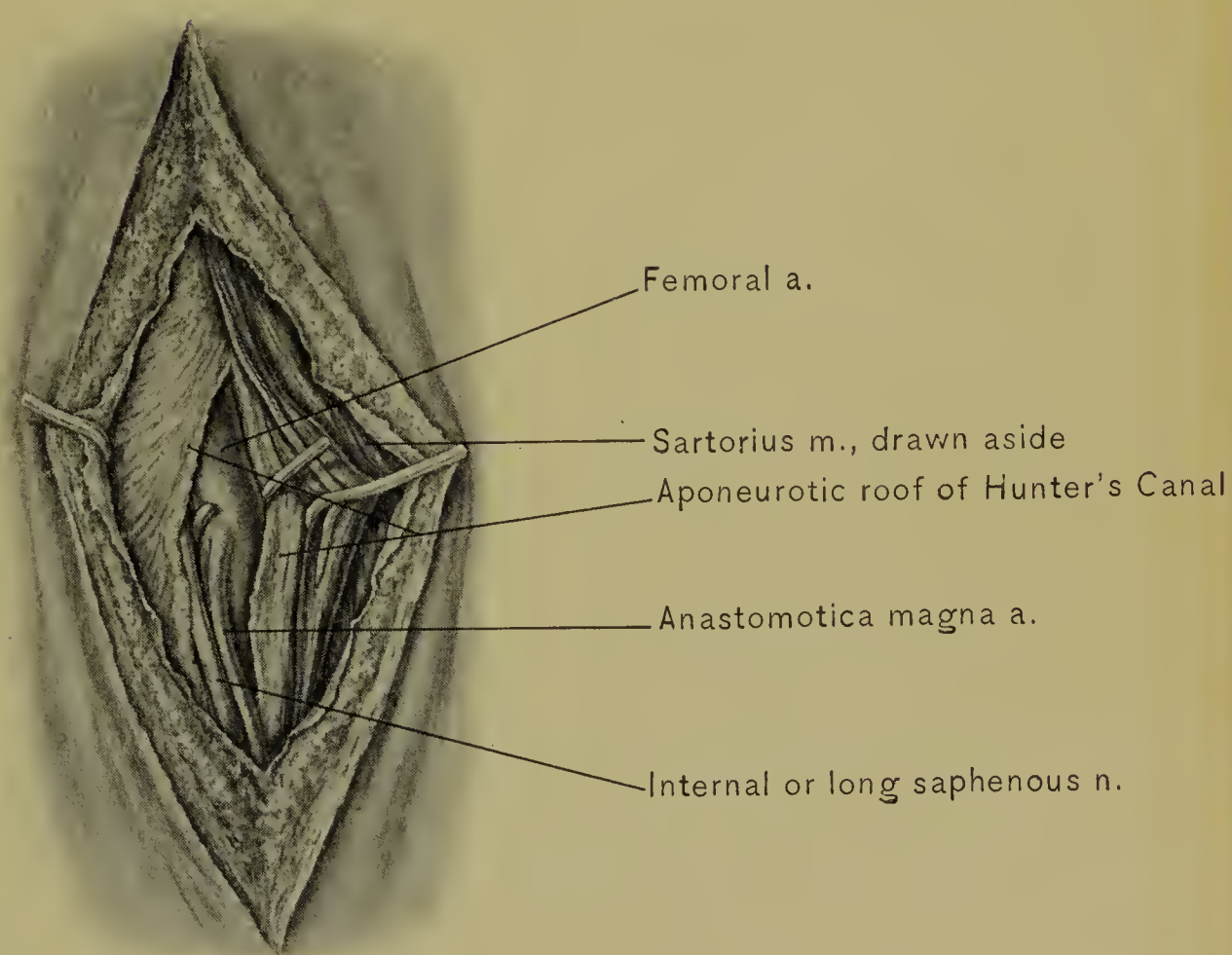
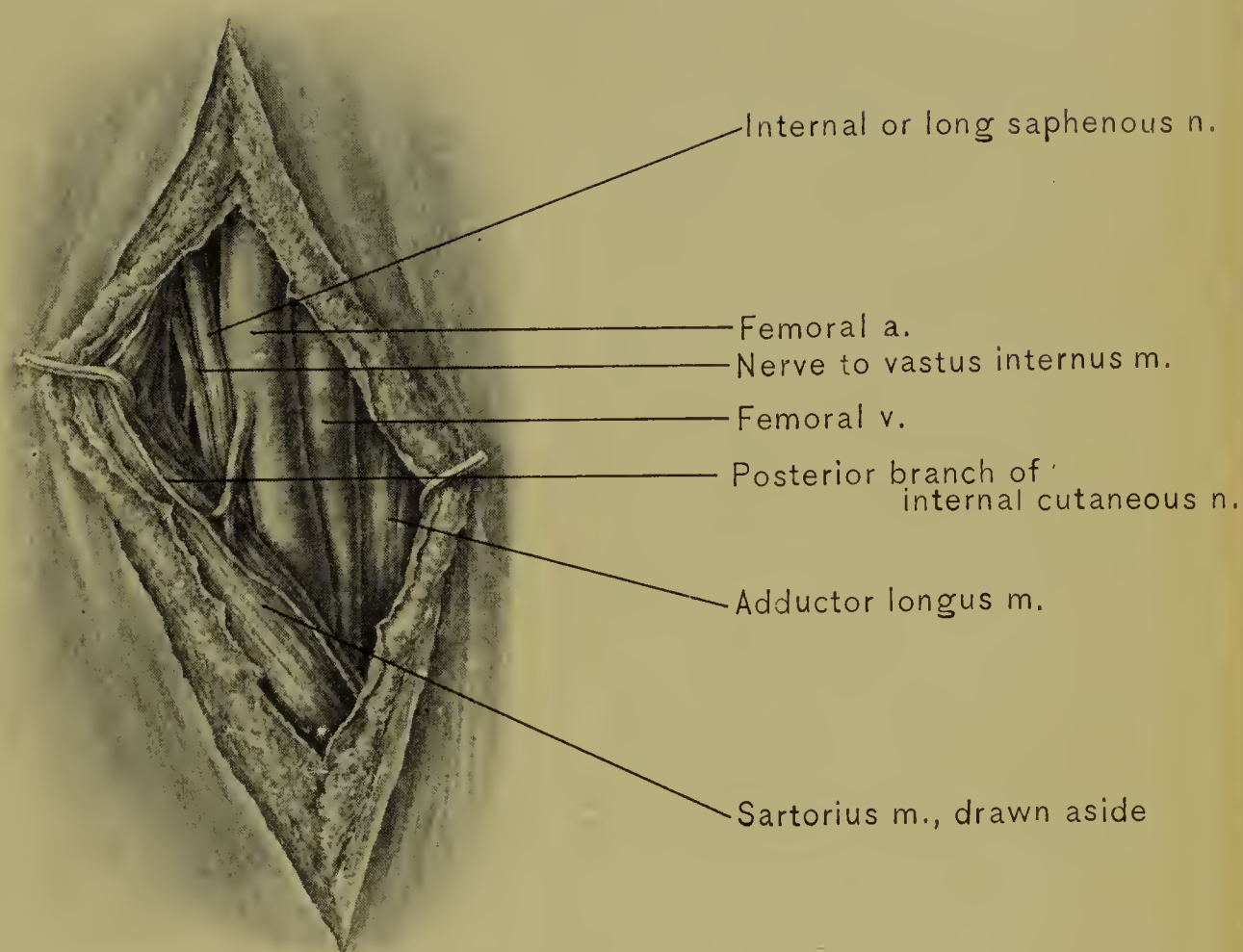
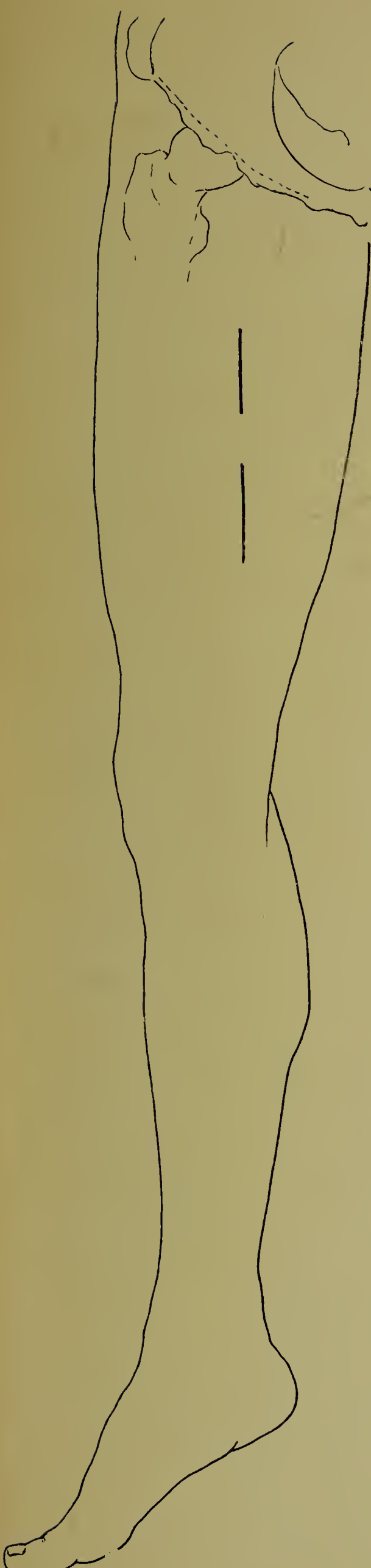
LIGATIONS OF THE ARTERIES.

The methods of ligation and the general rules to be observed have been given under ligations of arteries of the upper extremity.

Ligation of the Femoral Arteries.—The line of the common and superficial femoral arteries, with the thigh abducted and rotated outward, is from a point midway between the anterior superior iliac spine and the symphysis pubis to the tuberosity of the internal condyle. The common, and its continuation, the superficial femoral artery, lie on the following structures, from above downward: the psoas, pectineus, adductor brevis, and adductor longus muscles, and the tendon of the adductor magnus muscle. These arteries lie in Scarpa's triangle and are superficial, and their pulsations can readily be detected. From the apex of the triangle the superficial femoral artery enters Hunter's canal, which is about in the middle of the thigh. Associated with the artery in Hunter's canal are the internal saphenous nerve, the femoral vein, and the superficial part of the anastomotica magna artery. The relation of the superficial femoral artery to the vein throughout its course is important. In Scarpa's triangle the artery lies to the outer side of the vein, and on the same plane; in the apex of the triangle the artery is in front of the vein; in Hunter's canal the artery lies in



LINES OF INCISIONS FOR LIGATIONS AND NERVE STRETCHING.



LIGATION OF FEMORAL ARTERY IN SCARPA'S TRIANGLE AND IN HUNTER'S CANAL.

front of, and to the inner side of, the vein. The artery may be ligated at the base of Scarpa's triangle, at the apex of the triangle, or in Hunter's canal.

In *ligating the common femoral artery at the base of Scarpa's triangle* an incision is made directly over the artery, beginning a little above Poupart's ligament and extending downward for about three inches (7.5 centimeters). The skin and superficial fascia will be divided, with twigs from the external, middle, and internal cutaneous nerves, and small branches of the superficial epigastric and superficial circumflex iliac arteries with their veins. The cribriform fascia is then divided in the original line of incision and the sheath of the vessels exposed. Care must be exercised in cutting the cribriform fascia to avoid wounding the superficial external pudic and superficial epigastric arteries, which lie near the line of incision. The crural branch of the genito-crural nerve will be seen lying on the sheath of the vessels, but to the outer side. The sheath is then to be opened, and the ligature passed from within outward; that is, away from the vein.

The *collateral circulation* is established by the anastomoses formed between the internal pudic and the pudic branch of the femoral; between the gluteal and the external and internal circumflex and the first perforating; between the superficial circumflex iliac and the external circumflex; between the obturator and the internal circumflex; between the sciatic and the superior perforating and the internal circumflex; and between the comes nervi ischiadici and the first perforating.

In *ligating the superficial femoral artery at the apex of Scarpa's triangle* an incision is made in the line of the artery, beginning about one and a half inches (3.8 centimeters) below the middle of Poupart's ligament and extending downward for about three inches (7.5 centimeters). This will bring the middle of the incision over the apex of the triangle. The incision will divide the skin and superficial fascia, with twigs of the middle and internal cutaneous nerves, tributaries of the long saphenous vein, and small arterial twigs from the external pudic and superficial epigastric. The fascia lata is then to be incised in the same line as the original incision. This will expose the sartorius muscle at the outer and inferior part of the wound, and the internal saphenous nerve and the nerve to the vastus internus muscle lying to the outer side of the vessels. The muscle should be drawn outward, the sheath of the vessel opened, and the ligature passed from within outward. If great care be not exercised in passing the needle holding the ligature, the femoral vein will be wounded. The needle should hug the walls of the artery.

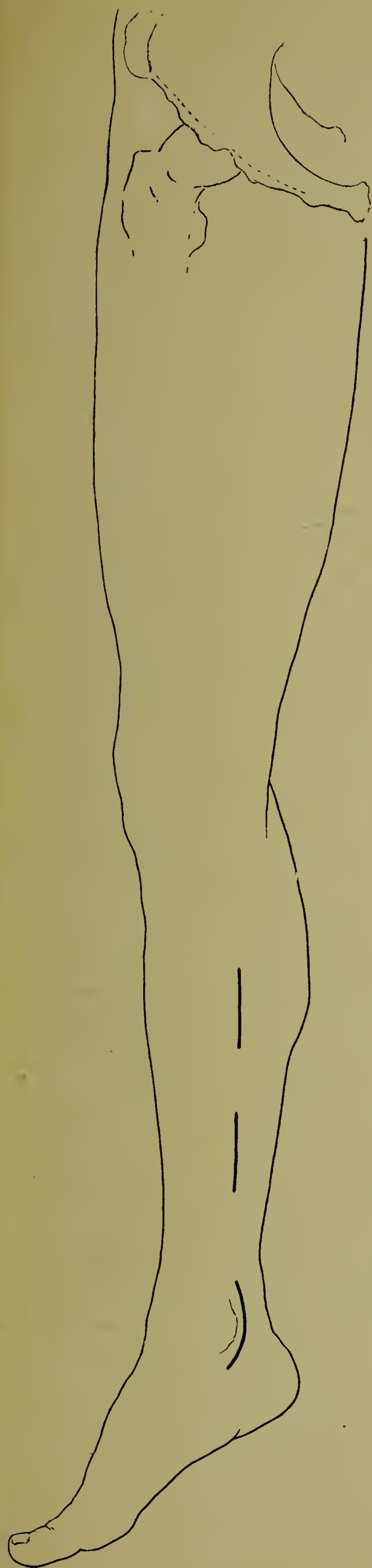
In *ligating the superficial femoral artery in Hunter's canal* the incision is made along the line of the artery, in about the middle of the thigh. The skin and superficial fascia will be divided, with twigs of the middle and internal

cutaneous nerves, and, at times, the internal cutaneous nerve itself. The long saphenous vein will be seen in the inner part of the wound, and must be drawn inward. The fascia lata is then incised and the sartorius muscle, which forms the roof of the canal, fully exposed. The fibers of this muscle can be easily recognized by their downward and inward direction. The muscle is drawn inward, when the artery can be observed entering the canal formed by the adductor magnus and the vastus internus muscles. The transverse fibers of the fascia covering the canal are divided and the sheath of the vessels exposed. The internal saphenous nerve will be seen to the outer side of the vessel. The ligature may be passed from either side.

The *collateral circulation* after the ligation of the superficial femoral is carried on by the anastomoses formed by the perforating branches of the profunda and the anastomotica magna of the femoral, with the articular arteries of the popliteal and the recurrent branch of the anterior tibial.

Ligation of the Popliteal Artery.—The popliteal artery extends from the opening in the adductor magnus to the lower border of the popliteus muscle. It is on a level with the tubercle of the tibia at its termination, where it divides into the anterior and posterior tibial arteries. It lies deeply in the popliteal space, being under the semimembranosus above and the gastrocnemius below. In the middle of the popliteal space it is ligated with difficulty, owing to its deep location, but in the upper or lower part of its course it may be readily tied. The relations of the popliteal artery should be borne in mind. In front of it are the femur, from which it is usually separated by a small quantity of loose fat; the posterior ligament of the knee-joint; and the fascia covering the popliteus muscle. It is covered by the popliteal vein and the internal popliteal nerve, and superficially, above, by the semimembranosus muscle; by fat in the middle of the space, and below by the gastrocnemius, plantaris, and soleus muscles. On the outer side are the biceps, the outer head of the gastrocnemius, and the plantaris muscles; and on the inner side, the semimembranosus and the inner head of the gastrocnemius muscles. The relations of the artery to the vein and the internal popliteal nerve are important. Above, the vein lies external to the artery and behind it; behind the joint it lies almost posterior to the artery, crossing it, to lie on its inner side in the lower part of the space. The internal popliteal nerve lies on a plane posterior to the vessels and at first to their outer side, crossing the artery below to lie on its inner side.

In *ligating the popliteal artery in the upper part* the leg is flexed to a right angle, and an incision is made about three inches (7.5 centimeters) long, beginning at the junction of the middle and lower thirds, and running parallel with



Internal or long saphenous v.

Cut tibial head of soleus m.

Posterior tibial n.

Deep transverse fascia

Posterior tibial a. and companion veins



Soleus m.

Internal or long saphenous v.

Soleus m.

Flexor longus digitorum m.

Posterior tibial a.



Tendon of tibialis posticus m.

Posterior tibial n.

Tendon of flexor longus digitorum m.

Tendon of flexor longus hallucis m.

Posterior tibial a.

LOCATION OF THE POSTERIOR TIBIAL ARTERY IN THE UPPER, MIDDLE, AND LOWER THIRD OF THE LEG.

the tendon of the adductor magnus. The incision divides the skin and superficial fascia with twigs from the internal and middle cutaneous nerves, and small branches of the sural and articular arteries with their veins. The anterior division of the internal cutaneous nerve may at times be exposed, and should be drawn to one side. The deep fascia is then divided and the sartorius muscle, the tendon of the adductor magnus, and the semimembranosus muscle exposed and drawn aside, and the artery located. The ligature is passed from either side, care being taken not to wound the deep branch of the anastomotica magna artery, which lies on the anterior surface of the adductor tendon.

In *ligating the popliteal artery in its lower third* the leg is extended and an incision about three inches (7.5 centimeters) long made over the artery, beginning at the center of the popliteal space. The skin and superficial fascia are divided, along with twigs of the small sciatic and internal saphenous nerves, and small branches of the articular and sural arteries with their veins. The external saphenous vein and nerve will be seen in the outer part of the wound, and care should be taken not to wound them. They should be drawn outward and the deep fascia divided. This will expose the heads of the gastrocnemius, between which will be found the popliteal artery. The two sural arteries will be seen on either side entering the heads of the gastrocnemius muscle. The external popliteal nerve and the popliteal vein, overlying the artery, should be drawn to the inner side and the ligature passed from the inner side.

The *collateral circulation* after ligation of the popliteal artery will be carried on by the anastomoses formed between the inferior articular and the anterior tibial recurrent below, and the superior articular, the anastomotica magna, and the external circumflex above.

Ligation of the Posterior Tibial Artery.—The posterior tibial artery extends from the lower border of the popliteus muscle to the deep concavity between the internal malleolus and the calcaneum, where it divides into the two plantar arteries. In the upper part of its course the artery lies on the tibialis posticus and flexor longus digitorum muscles, and in the lower part on the posterior surfaces of the tibia and the internal lateral ligament of the ankle-joint. The posterior tibial nerve at first lies to the inner side of the artery, but soon crosses over the latter, and at the middle and lower part of the leg is found to the outer side of the artery.

In *ligating the posterior tibial artery in its upper third* the leg is flexed and laid on its outer side. An incision about three inches (7.5 centimeters) long is then made along the inner edge of the tibia. The skin is divided with the superficial fascia, great care being taken, however, in dividing the superficial fascia to avoid

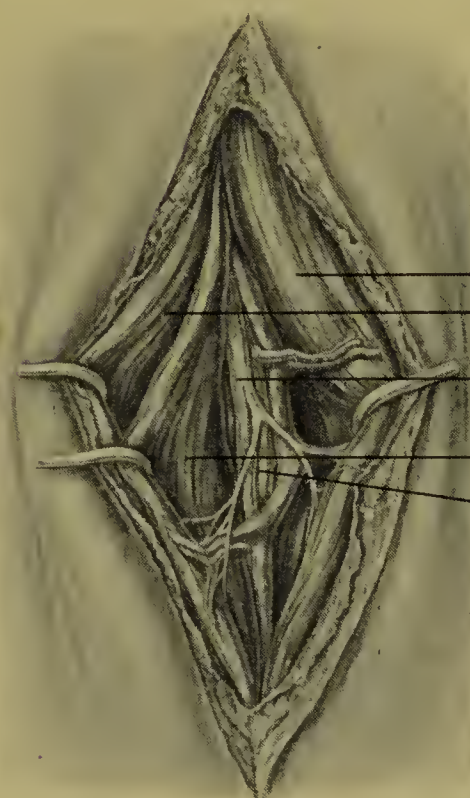
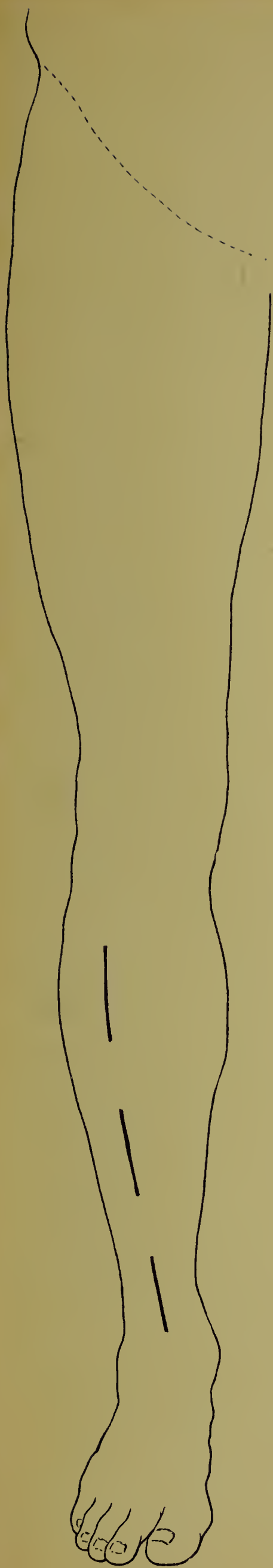
the internal saphenous vein and nerve, both of which lie in the line of incision. They should be drawn to one side. The deep fascia is then incised and the origin of the soleus muscle brought into view. This muscle should be detached from the tibia; if the soleus has not been fully recognized, there is danger of missing the vessel by going through the interspace between the heads of the gastrocnemius and thus going behind the vessel, or by detaching the tibialis posticus with the soleus, going in front of the artery. The under surface of the soleus presents a shining appearance, and a layer of fascia, the intermuscular septum, separates it from the tibialis posticus. On passing the finger toward the external aspect of the leg, the artery will be felt pulsating. The intermuscular septum should be incised in the line of the original incision and the vessel separated from the overlying connective tissue, the veins, and the nerve, and the ligature passed from without inward.

In *ligating the posterior tibial artery in its middle third* the incision is made in the middle of the leg over the internal edge of the tibia. The skin having been divided, the internal saphenous vein and nerve should be located and drawn aside, and the deep fascia then opened. The inner border of the soleus should be pushed aside, and the artery will then be found with the veins and the posterior tibial nerve to its outer side. The artery should be separated from the vein and nerve, and the ligature passed from without inward.

In *ligating the posterior tibial artery at the ankle* the incision should be semi-circular in shape, and should be made midway between the internal malleolus and the calcaneum. The skin and superficial fascia are divided, with twigs of the calcanean nerve, and small branches of the internal plantar artery. The deep fascia should be carefully incised and the vessel exposed. To its outer side will be found the tendons of the tibialis posticus and flexor longus digitorum muscles, and to its inner side the posterior tibial nerve and the tendon of the flexor longus hallucis. The accompanying veins lie on either side. They should be separated from the artery and the ligature passed from without inward.

Ligation of the Peroneal Artery.—The peroneal artery arises from the posterior tibial about an inch (2.5 centimeters) below the lower border of the popliteus muscle, and, after passing to the outer side of the leg, runs downward along the posterior internal surface of the fibula and at the lower third of the leg it pierces the interosseous membrane as the anterior peroneal artery. Throughout most of its course the vessel lies within the substance of the flexor longus hallucis-muscle, and is covered by the fibular origin of the soleus.

In *ligating the peroneal artery* the incision should be made over the external border of the fibula, on a level with the fibular origin of the soleus muscle. The incision divides the skin and superficial fascia, with twigs from the cutaneous



LIGATION OF ANTERIOR TIBIAL ARTERY IN THE UPPER, MIDDLE, AND LOWER THIRDS OF THE LEG.

branch of the internal popliteal nerve, and some tributaries of the internal saphenous vein. The deep fascia is then incised and the origin of the soleus exposed. The muscle is separated from the bone and the fibers of the flexor longus hallucis are brought into view. These fibers and the intermuscular septum should be divided, and the artery will then be found lying in the angle formed by the junction of the intermuscular septum with the fibula. The ligature may be passed from either side.

Ligation of the Anterior Tibial Artery.—The line for the anterior tibial artery, which closely corresponds to the general course of that vessel, is drawn from a point midway between the tubercle of the tibia and the head of the fibula, to the middle of the intermalleolar space in front. The artery passes above the intermuscular septum at the lower border of the popliteus muscle to reach the anterior aspect of the leg. In the upper third of its course the anterior tibial artery lies between the tibialis anticus and the extensor longus digitorum muscles and rests upon the interosseous membrane. In the middle of the leg the artery is in relation with the tibialis anticus on its inner side and the extensor proprius hallucis on its outer side. In the lower third of its course, just above the ankle, it lies between the tendon of the extensor proprius hallucis on the inside, and the tendon of the extensor longus digitorum on the outside. The anterior tibial nerve lies to the outer side of the artery above, in front of it in the middle of the leg, and again to its outer side below.

In *ligating the anterior tibial artery in its upper third* an incision is made over the course of the artery, beginning on a level with the head of the fibula. The incision will divide the skin and superficial fascia together with twigs from the internal saphenous nerve and tributaries of the internal saphenous vein. The intermuscular space between the tibialis anticus and the extensor longus digitorum muscles is to be located and the deep fascia then divided. The muscles should be separated, when the artery will be found lying on the interosseous membrane, the veins being to either side and the nerve to the outer side. The artery should be separated from the veins and nerve, and the ligature passed from without inward.

In *ligating the anterior tibial artery in its middle third* an incision about three inches (7.5 centimeters) long should be made over the course of the vessel. The skin and superficial fascia, with twigs of the internal saphenous nerve and tributaries of the internal saphenous vein, will be divided. After dividing the deep fascia the tibialis anticus and the extensor longus digitorum muscles should be separated, when the extensor proprius hallucis will be seen lying between them. This muscle should be separated from the tibialis anticus, when the artery will be found between the two, with the veins and nerve in the same

relative position as in the upper third, except that the nerve may be more anterior. The ligature should be passed from without inward.

In *ligating the anterior tibial artery in its lower third* an incision about two inches (5.0 centimeters) long should be made over the line of the vessel, beginning about three inches (7.5 centimeters) above the tibio-tarsal articulation. The skin and superficial fascia will be divided, with twigs from the internal saphenous and musculo-cutaneous nerves, and tributaries of the internal and external saphenous vein. The second tendon from the crest of the tibia, the tendon of the extensor proprius hallucis, should then be located and the deep fascia opened to its outer side. The space between the tendons of the extensor proprius hallucis and the extensor longus digitorum should be enlarged, when the artery will be found in this space, with the nerve to the outer side. The ligature should be passed from without inward.

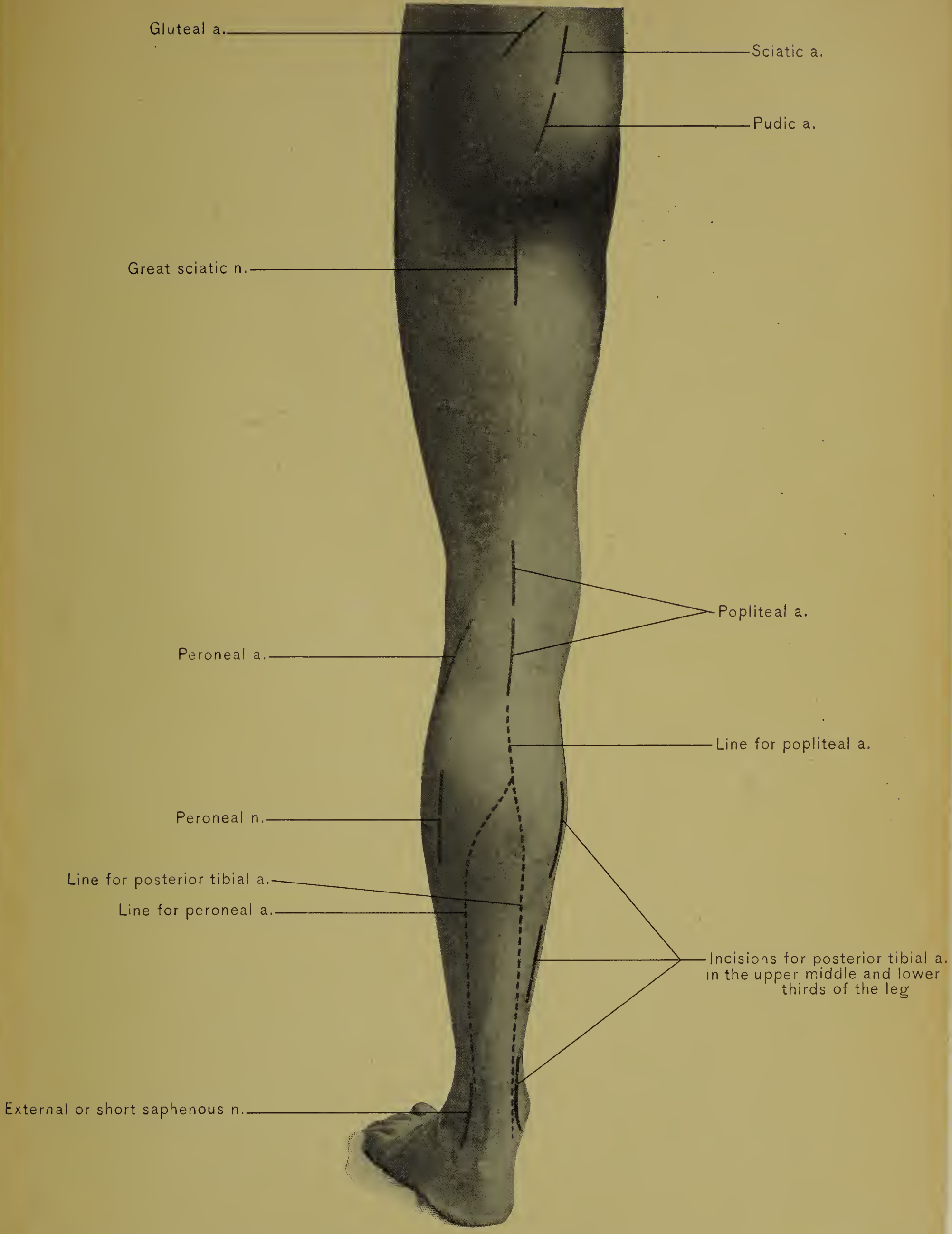
Ligation of the Dorsalis Pedis Artery.—The line of the dorsalis pedis artery is from a point midway between the two malleoli to a point midway between the anterior extremities of the first and second metatarsal bones. Its course is over the first interosseous space.

In *ligating the dorsalis pedis artery* the incision should be made over the artery. The skin and superficial fascia will be divided, with twigs of the anterior tibial and musculo-cutaneous nerves, and tributaries of the internal and external saphenous veins. The deep fascia is then divided, and the artery found to the inner side of the inner tendon of the extensor brevis digitorum. The ligature should be passed from without inward.

NERVE STRETCHING.

The **great sciatic nerve** extends from the lower border of the pyriformis muscle to a little below the middle of the thigh, where it divides into its terminal branches. It leaves the pelvis through the great sacro-sciatic foramen, and passes down the thigh beneath the gluteus maximus muscle, and between the inner and outer hamstring muscles. At the lower border of the gluteus maximus muscle, the nerve lies about midway between the tuber ischii and the great trochanter. It is accompanied by the arteria comes nervi ischiadici. The small sciatic nerve lies in the same course as the great sciatic, but superficial to it.

To reach the nerve, an incision should be made along the middle of the thigh, beginning on a level with the lower border of the gluteus maximus muscle. The skin and superficial fascia will be divided, with branches of the small sciatic nerve and of the posterior femoral cutaneous veins. The deep fascia should then be opened in the same line, and the interval between the semimem-



LINES OF INCISION FOR NERVE STRETCHING.

branosus and semitendinosus on the inner side of the thigh, and the biceps on the outer side, should be enlarged, when the nerve will be found at the bottom of the interval. (See page 643.)

In operating on the **internal popliteal nerve** the incision should be the same as that used in the ligation of the lower part of the popliteal artery. In this part of its course the nerve lies to the inner side of the artery, being separated from it by the popliteal vein. The structures divided will be the same as those in the ligation of this part of the artery.

The **peroneal nerve** passes from its point of origin at the bifurcation of the great sciatic, around the outer aspect of the knee between the tendon of the biceps muscle and the head of the fibula. It then pierces the origin of the peroneus longus muscle and divides into the anterior tibial and musculo-cutaneous nerves.

To reach the nerve, an incision should be made over and parallel to the tendon of the biceps, extending downward for about an inch (2.5 centimeters) beyond the head of the fibula. The incision will divide the skin and superficial fascia with twigs from the communicans peronei nerve and the external saphenous vein. The deep fascia should then be divided, and the nerve found in the line of the biceps tendon. The most accessible part of the nerve is just above its entrance into the peroneus longus muscle.

The **anterior crural nerve** may be stretched through an incision made about three-fourths of an inch (2.0 centimeters) external to that advised in the ligation of the femoral artery at the base of Scarpa's triangle; that is, a little external to a point midway between the anterior superior spine of the ilium and the symphysis pubis. The same structures will be divided as in the operation of ligation. The nerve will be found to the outer side of the artery, in the groove between the iliacus and psoas muscles.

The **anterior tibial nerve** corresponds to the same line, practically, as that used in locating the anterior tibial artery—namely, from a point midway between the head of the fibula and the tubercle of the tibia to the middle of the intermalleolar space in front. The nerve in the upper part of its course lies to the outer side of the artery, in the middle of the leg it lies in front of, and in the lower part of its course again to the outer side of the artery. The incision should be made in the middle of the leg over the internal border of the tibia. The skin having been divided, the internal saphenous vein and nerve should be located and drawn aside, and the deep fascia then divided. After separating the extensor longus digitorum and the extensor longus hallucis from the tibialis anticus the nerve is found in front of the artery.

To expose the **external cutaneous nerve**, an incision should be made parallel with and over the fibers of the sartorius muscle, just below its origin.

The incision will divide the skin and superficial fascia, with twigs of the cutaneous branch of the external cutaneous and small branches of the superficial external circumflex iliac artery with their veins. The fascia lata should be carefully incised in the line of the original incision, when the nerve will be exposed, lying on the sartorius muscle and crossing the line of incision at a right angle.

The **short or external saphenous nerve** may be exposed by an incision parallel with the outer border of the tendo Achillis and midway between that structure and the external malleolus. The skin should be divided, when the nerve will be found in the superficial fascia.

The **internal or long saphenous nerve** may be exposed by an incision made parallel with the posterior edge of the sartorius muscle, on a level with the internal tuberosity of the tibia. The incision will divide the skin and superficial fascia, with twigs of the internal cutaneous nerve and small branches of the anastomotica magna artery with their veins. The long saphenous vein will be exposed, and should be drawn to one side. The deep fascia should be divided and the tendons of the sartorius and gracilis exposed. By separating these tendons, the nerve will be seen on its way to pass between these tendons and to pierce the deep fascia.

The **musculo-cutaneous nerve** is exposed by an incision made in the middle or lower part of the leg. The course of the nerve corresponds to a line drawn from the head of the fibula to a point midway between the middle of the front of the ankle and the external malleolus.

To expose the nerve in the middle of the leg, the incision should be made in this line. The incision will divide the skin and the superficial and deep fascia, when the extensor longus digitorum muscle will be exposed. The nerve will be found between the outer border of this muscle and the peroneus longus. In the lower part of the leg the nerve is above the deep fascia, and can be exposed by an incision in the line of the nerve. The skin should be divided, when the nerve will be found in the superficial fascia. (See page 775.)

INDEX.

In this Index the references in **heavy-face type** are to the pages containing plates illustrating the subject named. References in regular type are to the text.

- A.**
- Abdomen, the, 17
 blows upon, 79
 boundaries, 17
 cutaneous n., 46
 anterior, 49, **47**
 lateral, 49, **47**
 dissection, 40, **41**
 fascia, superficial, 42, **44**
 form, 17
 incision for dissection, **40**
 landmarks, 18, **19**
 lymphatics, 392
 superficial, 46
 palpation, 103
 pendulous, 18
 regions, 111
 contents, 112
 skin of, 18
 surface anatomy, 18
 transverse crease, 22
 veins, superficial, 46
- Abdominal aorta, 269, **254, 281**
 aneurysm, 280
 bifurcation, 27
 branches, 270
 compression, 24, 280
 line, **26**
 pulsation, 24
 relations, 269
- cavity, 109
 boundaries, 110
 contents, 109, 110
 dissection, 106
 divisions, 110
- intercostal n., 66
 palpation, 18
 parietes, 41
 ring, external, 23, 55, **51, 57**
 pillars, 55
 internal, 23, 80
 structures in, 111
- sympathetic n., 284
 viscera, **133**
 diagram, **30, 31, 34, 35, 113**
 location, 27
 relations, 150
- wall, fascia, deep, 49
 ligament, triangular, 59, **54, 81, 84, 85**
 limits of, 22
 lymphatic glands, 393
 nerve supply, 103
- Abdominal wall, openings, 111
 pus in layers, 72
 thickness, 41
 transverse section, **61**
 wounds, 104
- Abductor hallucis m., 687, **685, 691, 695**
 action, 687
 insertion, 687
 nerve supply, 687
 origin, 687
- minimi digiti m., 687, **685, 691**
 action, 687
 insertion, 687
 nerve supply, 687
 origin, 687
- Abscess en bissac, 684
 gluteal, 620
 hip-joint, 706
 mediastinal, 439
 of liver, 157
 perinephric, 255
 peri-pleuritic, 444
 popliteal, 647, 654
 psoas, 304, 563, 593
 thigh, 563
 under fascia lata, 563
 under plantar fascia, 684
- Accessory obturator n., 294, 597, **359**
- Achillis tendon, 546, 663
- Acromio-clavicular joint, 400
- Acro-uterine ligament, **331**
- Adductor brevis m., 598, **583, 595**
 action, 598
 insertion, 598
 nerve supply, 598
 origin, 598
 relations, 598
- longus m., 594, **579**
 action, 594
 hernia of, 601
 insertion, 594
 landmark in hernia, 594
 nerve supply, 594
 origin, 594
 relations, 594
- magnus m., 598, **561, 576, 583, 595, 625, 635, 657**
- Adductor magnus m., action, 599
 insertion, 599
 nerve supply, 599
 origin, 598
 relations, 599
- muscles of thigh, 593
 contraction, 600
 injuries, 600
 tubercle, 545, 599
- Agminated glands, 205
- Ague cake, 37
- Alcock's canal, 318
- Ampulla of rectum, 338
 of Vater, 182, 243, **239, 242**
- Amputation at hip-joint, 768
 racket incision, 773
 transfixion method, 774
- at knee-joints, 764
- Chopart's, 548, 761
- Hey's, 761
- Lee's, 764
- Lisfranc's, 760
- of foot, 757
- of leg, 763, **765**
- of thigh, 767, **770**
 transfixion method, 535
- of toes, 757
- Pirogoff's, 763
- Symes', 548, 762
- Teale's, 764
- Wyeth's, 768
- Anal canal, 338
 fascia, 318
- Anastomosis, crucial, 585, 641
 longest, 426
- of circumflex a., internal, 585
- of colic a., 195
- of epigastric a., superior, 426
- of gastric a., 186
- of gastro-epiploic a., left, 189
 right, 189
- of hemorrhoidal a., superior, 199
- of ileo-colic a., 196
- of lumbar a., 279
- of obturator a., 333, 597
- of pancreatico-duodenal a., inferior, 195
 superior, 185
- of peroneal a., anterior, 670
- of phrenic a., 270
- of pyloric a., 185

Anastomosis of sciatic a., 638, 641
 Anastomotica magna a., 581
 Aneurysm of aorta, 458, 518
 of popliteal a., 653
 Angina pectoris, 483
 Angle, subchondral, 22
 subcostal, 22
 Ankle, dislocation, 737
 surface markings, 546
 Ankle-joint, 717
 blood supply, 719
 effusion, 720
 excision, 745
 ligament, annular, anterior,
 605
 external, 606
 internal, 605,
 anterior, **721**
 external, 719
 deltoid, **721**
 movements, 719
 nerve supply, 719
 synovial membrane, 718
 Annular ligament of ankle-joint,
 anterior, 605, 718
 external, 606, 719
 internal, 605
 Annulus fibrosus, 528
 ovalis, 487, **485**
 Ano-coccygeal body, 338
 Anomalies of femoral a., 581
 Anteflexion of uterus, 368
 Anterior ligament of knee-joint,
 709
 Anteversion of uterus, 368
 Aorta, abdominal, 269, **254, 281**
 aneurysm, 280
 bifurcation, 27
 branches, 270
 compression, 24, 280
 ligation, 280
 line, **26**
 pulsation, 24
 relations, 269
 aneurysm, 518
 arch, 456, **477, 481**
 sinus, 456
 thoracic, 456, 514, **465, 481**
 aneurysm, 458
 ascending, 456
 branches, 517
 descending, 457
 divisions, 456
 relations, 514
 transverse, 457
 Aortic arch, 456
 plexus of n's, 290, **295, 355**
 vestibule, 492
 Apex beat, 409
 of lungs, 501
 Aponeurosis of oblique m., exter-
 nal, 50, **47, 54,**
 64, 74
 internal, 60, **64, 88**
 of transversalis m., **74**
 Appendectomy, 217
 Appendices epiploicæ, 176, 208
 Appendicitis in typhoid fever,
 209
 Appendicular a., 196, 210
 vein, 196
 Appendiculo-ovarian ligament,
 142, **315**

Appendix, auricular, 487, **477,**
 485
 vermiform, 172, **154, 155,**
 211, 312
 blood supply, 210
 coats, 209
 length, 172
 lymphatics, 210
 mesentery, 141
 nerves, 210
 nerve supply, 210
 perforation, 142
 positions, 172, **174**
 removal, 217
 retro-peritoneal hernia
 of, 175
 structure, 209
 Arbor vitæ, 369
 Arch, crural, 56, 530
 deep, 569
 structures in, 111
 femoral, 56
 foot, lateral, 731
 longitudinal, 730
 transverse, 731
 of aorta, 456, **477, 481**
 plantar, 688, 697, **699**
 venous, dorsal, of foot, **603**
 Arcus tendineus, 318
 Arteria aberrans, 427, 518
 Arteries, bronchial, 517
 coronary, 458
 diaphragmatic, 518
 esophageal, 517
 intercostal, 517, **481**
 mediastinal, 518
 of leg, course, 547
 of pelvis, 323
 of rectum, 339
 of sternum, **245**
 plantar, **691**
 sural, 652
 Arteriosclerosis, 483
 Artery, anastomotica magna, 581
 aortic intercostal, **424**
 appendicular, 196, 210
 articular, knee-joint, 651
 axillary, **77, 424**
 azygos, of knee, 652, **673,**
 677
 of vagina, 330
 brachio-cephalic, 459
 calcanean. external, 675,
 673
 internal, 675
 cardiac, of gastric, 270
 carotid, common, **477**
 left, 460, **481**
 anomalous ori-
 gin, 460
 relations, 460
 right, **481**
 cervical, of uterine, 329, **331**
 circular, of cervix, 330
 circumflex iliac, deep, 71,
 328, **77, 424**
 external, 582, **583, 631**
 internal, 585, **583, 631**
 anastomosis, 585
 iliac, superficial, **551**
 coccygeal, 641
 colic, 195, **148**
 left, 279, **198, 199**

Artery, colic, middle, 195, 278,
 138, 194, 198
 anastomosis, 195
 right, 195, 278, **138,**
 194
 anastomosis, 195
 colica dextra, 278
 media, 278
 sinistra, 279
 collateral digital, **691**
 comes nervi ischiadici, 641
 phrenici, 450, **453**
 communicating (foot), 618
 of leg, 673
 coronary, 186, 277, **245,**
 490. Vide A., gastric
 diseases, 483
 left, 458, 480, **485**
 right, 458, 480
 cremasteric, 278, **57**
 cystic, 186, **183**
 course, 186
 digital (foot), 689
 dorsal (foot), **613**
 dorsal, of clitoris, 334
 of penis, 333
 dorsalis hallucis, 618, **613**
 pedis, 617, **609, 613**
 branches, 618
 course, 548
 ligation, 788
 guide, 607
 line for, 617
 relations, 617
 epididymal, 278
 epigastric, deep, 24, 76, 327,
 70, 77, 133,
 138, 139, 312,
 424
 cremasteric branch,
 79
 line, **26**
 pubic branch, 79
 inferior, **77, 424**
 superficial, 45, 555, **44,**
 551
 superior, 76, 420, 426,
 70, 421
 anastomosis, 426
 esophageal, of gastric, 270,
 183
 femoral, common, 577, **57,**
 322, 576, 579,
 583
 anomalies, 581
 branches, 581
 course, 536
 ligation, 774, 779,
 777
 collateral circu-
 lation, 779
 relations, 578
 deep, 582. *Vide A., pro-*
 funda femoris.
 branches, 582
 relations, 582
 superficial, 577
 branches, 581
 course, 536
 ligation, 779
 collateral circu-
 lation, 780
 line for, **776**

- Artery, femoral, superficial, relations, 578
 fibular, superior, 612
 funicular, 372
 gastric, 186, 270, **143, 183, 223, 245, 271**
 anastomosis, 186
 branches, 186, 270
 course, 186
 gastro-duodenal, 185, 277, **183, 223, 245, 271**
 origin, 185
 gastro-epiploic, left, 189, 226, 277, **183, 188, 245**
 anastomosis, 189
 right, 189, 277, **183, 188**
 anastomosis, 189
 vena comes, **183**
 gastro-epiploica dextra, 277
 sinistra, 277
 gluteal, 335, 628, **322, 331, 630, 635**
 course, 541
 ligation, 335, 628
 superior, **630**
 hemorrhoidal, middle, 329, **322, 331, 373**
 superior, 199, 279, **198, 322, 331, 373**
 anastomosis, 199
 hepatic, 182, 270, 277, **161, 183, 188, 223, 227, 231, 239, 245, 267**
 branches, 185, 277
 course, 185
 origin, 185
 hypogastric, 106, 328, 496
 ileo-colic, 196, 278, **151, 194**
 anastomosis, 196
 branches, 196
 iliac, circumflex, superficial, 46, 555, **44, 551**
 common, 323, **194, 198, 322**
 bifurcation, **26**
 branches, 324
 left, 323
 relations, 323
 ligation, 324
 collateral circulation, 324
 line, 27, **26**
 right, 323
 relations, 323
 external, 324, **151, 154, 322, 331**
 ligation, 386, **325, 387**
 line, 27, **26**
 relations, 327
 internal, 328, **322, 331**
 branches, **322**
 ligation, 324
 relations, 328
 of obturator, 330
 ilio-lumbar, 334, **331**
 infracostal, lateral, 425
 innominate, 403, 459, **465, 475, 477, 481**
 ligation, 459
- Artery, intercostal, 426, 517, **465, 520**
 anterior, 425, **77, 421**
 aortic, 427
 superior, 427
 interosseous, dorsal (foot), 618, **613**
 lumbar, 279, **267**
 anastomosis, 279
 malleolar, **613**
 external, 612
 internal, 612, 675
 mammary, internal, 403, 420, **77, 421, 424, 481**
 branches, 425
 ligation, **401**
 marginal, **481**
 mediastinal, 425, **421**
 mesenteric, inferior, 24, 199, 279, **143, 198, 223, 227, 267, 322**
 branches, 199
 superior, 24, 190, 229, 278, **138, 143, 194, 198, 223**
 branches, 195
 metatarsal, 618
 musculo-phrenic, 420, 426, **421**
 nutrient of femur, 585
 of fibula, 670
 of tibia, 675
 obturator, 330, 597, **322, 331, 583**
 anastomosis, 333, 597
 anomalous, 79
 branches, 330
 irregular, **57**
 of the bulb, 333
 of corpus spongiosum, 333
 of vas deferens, 329, **322**
 ovarian, 278, **254**
 branches, 279
 pancreatic, 185
 pancreatica magna, 226
 pancreaticæ parvæ, 226
 pancreático-duodenal, inferior, 195, 229, 278, **194, 223**
 anastomosis, 195
 superior, 185, 277, **223**
 anastomosis, 185
 perforating, 425
 of foot, anterior, 689
 posterior, 688
 of thigh, 585
 first, 585, **583**
 fourth, 586
 second, 585, **583**
 third, 586, **583**
 pericardial, 517, **481**
 peroneal, 670, **673, 677**
 anterior, 612, 670, **613, 673**
 anastomosis, 670
 ligation, 675
 line for, **789**
 posterior, 675, **673**
 phrenic, 270, **223, 267, 271, 281**
 anastomosis, 270
- Artery, phrenic, superior, 425
 plantar, external, 688, **691, 695**
 branches, 688
 course, 548
 relations, 688
 internal, 689, **681, 691, 695**
 course, 549
 popliteal, 651, **649, 673, 707**
 aneurysm, 653
 branches, 651
 course, 545
 external, **613**
 injury, 652
 ligation, 653, 780
 line for, **789**
 princeps hallucis, **681, 699**
 profunda femoris, 582, **583**.
Vide A., femoral, deep.
 pudic, external, deep, 581
 superficial, 555, **44, 551**
 internal, 333, 641, **322, 331, 631, 635**
 branches, 334
 course, 541
 ligation, 641
 relations, 334
 pulmonary, 463, **453, 465, 475, 477, 485, 510, 511, 521**
 left, 464
 relations, 463
 right, 463, **481**
 pyloric, 185, **183, 223, 245, 271**
 anastomosis, 185
 renal, 24, 278, **254, 281**
 sacral, **331**
 lateral, 335
 middle, 279, **322**
 sciatic, 334, 638, **322, 631, 635**
 anastomosis, 638, 641
 branches, 641
 ligation, 641, **643**
 sigmoid, 199, 279, **198**
 spermatic, 89, 278, **254, 267**
 branches, 278
 splenic, 226, 277, **143, 188, 191, 223, 227, 239, 267, 271, 275**
 branches, 226, **188**
 sternal, 425, **421, 438**
 subclavian, **77, 424, 453, 477**
 left, 460, **475, 481**
 relations, 460
 right, 459, **481**
 subcostal, 517
 suprarenal, 24, 298
 inferior, 278, **254, 281**
 middle, 278, **254, 281**
 superior, 278, **254, 281**
 sural, external, **649**
 internal, **649**
 tarsal, 618
 testicular, 279
 thoracic, long, **77, 424**
 superior, **424**

Artery, thymic, 425
 thyroidea ima, 459
 tibial, anterior, 608, **673**,
677
 branches, 611
 course, 547
 incision to expose,
 776
 injuries, 611
 ligation, 787, **785**
 guide, 605
 line for, 611, **776**
 relations, 611
 posterior, 669, 688, **665**,
 673
 bifurcation, **699**
 course, 547
 ligation, 670, 783,
 781
 line for, **789**
 recurrent, 612, **613**
 posterior, 611
 umbilical, 328
 uretal, 278
 uterine, 329, **331**, **373**
 vaginal, 330, **331**, **373**
 vasa brevia, 190, **188**
 of splenic, 226
 vasa intestini tenuis, 196, 278,
194
 vesical, inferior, 329
 middle, 329, **322**, **331**
 superior, 329, **322**, **331**
 of obturator, 330
 xiphoid, **421**
 Articular a., knee-joint, 651
 Articulation, acromio-clavicular,
 400
 ankle, 717. *Vide* Ankle-
 joint.
 astragalo-scaphoid, 723
 calcaneo-astragaloid, ante-
 rior, 720
 blood supply, 723
 nerve supply, 723
 posterior, 720
 calcaneo-cuboid, 724
 chondro-sternal, ligaments,
 529
 costo-chondral, 530
 cubo-cuneiform, 727
 cubo-metatarsal, 728
 foot, guides, 548
 interchondral, 530
 intercuneiform, 727
 intermetatarsal, 728
 blood supply, 729
 ligaments, 729
 movements, 729
 nerve supply, 729
 interphalangeal, 729
 blood supply, 729
 ligaments, 729
 movements, 729
 nerve supply, 729
 knee. *Vide* Knee-joint.
 medio-tarsal, 723
 metatarso-phalangeal, 729
 blood supply, 729
 ligaments, 729
 movements, 729
 nerve supply, 729
 scapho-cuboid, 724

Artery, scapho-cuneiform, 724
 ligaments, 724
 sterno-clavicular, 400
 tarsal, 720
 tarso-metatarsal, 727
 blood supply, 728
 ligaments, 727
 movements, 728
 nerve supply, 728
 thorax, 527
 tibio-fibular, blood supply,
 717
 inferior, 717
 ligaments, 717
 movements, 717
 nerve supply, 717
 superior, 716
 ligaments, 716
 Ascending colon, 175, **194**
 position, 38
 Ascites, cause of, 115
 Aspiration of pericardium, **408**
 of pleura, **408**
 Asthma, 513
 Astragalo-scaphoid articulation,
 723
 ligament, 723, **721**
 Astragalus, dislocation, 738
 excision, 745
 line of incision, **743**
 fracture, 757
 Atresia of cervix of uterus, 367
 of vagina, 378
 Auerbach's plexus, 206
 Auricle of heart, 480, **485**
 appendix, 487
 left, 491, **481**, **490**
 right, 484, **481**
 openings, 484
 Auricular appendix, 487, **477**,
485
 septum, **490**
 Auriculo-ventricular furrow, 480
 opening, left, 492
 right, 488
 Axillary a., **77**, **424**
 line, 404
 anterior, 404
 posterior, 404
 Axis, celiac, 270, **223**, **239**, **245**,
254, **271**
 Azygos a. of knee, 652, **673**,
677
 of vagina, 330

B.

Band, ilio-tibial, 545
 moderator, 488
 Barker's operation, 572
 Barrel-shaped chest, 398
 Bas fond of bladder, 343
 Bassini's operation for hernia, 101
 Bertini columns, 261, **259**
 Biceps m., thigh, 656, **657**
 action, 656
 insertion, 656
 nerve supply, 656
 origin, 656
 Bicuspid valve, 492
 Bifurcation of aorta, abdominal,
 27

Bifurcation of common iliac a.,
26
 Bile duct, common, 181, 243, **161**,
183, **227**, **231**,
239, **242**, **271**
 course, 181
 surgery, 182
 ducts, structure, 243
 Bladder, 313, 340, **349**
 base, 343
 bas fond, 343
 blood supply, 347
 body, 343
 capacity, 340
 cervix, 343
 coats, 345
 exstrophy, 22
 female, 385
 blood supply, 385
 lymphatics, 385
 nerve supply, 385
 ligaments, 346
 false, 345, 347
 lateral, 120, 314
 posterior, 120, 314
 superior, 314
 peritoneal, 131
 true, 323, 346
 lateral, 345
 superior, 345
 lymphatics, 347
 movements, 343
 neck, 343
 nerve supply, 347
 position, 340
 relation of peritoneum, 344
 relations, 346
 rupture, 317, 347
 sacculi, 345
 sphincter m., internal, 345
 structure, 345
 summit, 340
 tapping, 344
 trigone, **331**
 veins, 347
 Blood supply of right iliac fossa,
 209
 Blue baby, 487
 Body, ano-coccygeal, 338
 Boundaries of abdomen, 17
 Bowman capsule, 261
 Brachial n. plexus, **453**
 Brachio-cephalic a., 459
 vein, 447
 Breast, pigeon-, 23, 398
 Broad ligament of uterus, 120,
 371, **373**
 Bronchi, 467
 divisions, 507
 foreign bodies, 467
 primary, 404
 Bronchial a's, 517
 veins, 517, **475**
 Bronchotomy, 468
 Bronchus, eparterial, 507
 hyparterial, 507
 left, 467
 right, 467
 Brunner's glands, 205
 Bryant's line, **534**
 triangle, 535, **534**
 Bubo, 393, 555
 Bubonocoele, 94, 98, 555

Bulb, a. of, 333
 Bursa, ilio-psoas, 593
 patellæ, 591
 prepatellar, **707**
 suberureus, 715
 under gluteus maximus m., 623

Bursæ, knee-joint, 715
 popliteal space, 654
 Buttocks, 541, 619
 cutaneous n's, 619
 dissection, 619
 fold, 541
 landmarks, bony, 541
 muscles, 623, **657**

C.

Calcanean a., external, 675, **673**
 internal, 675
 nerve, internal, 676
 Calcaneo-astragaloid articulation,
 anterior, 720
 nerve supply, 723
 posterior, 720
 ligament, antero-internal, 720
 external, 723
 internal, 723
 interosseous, anterior, 720
 posterior, 723

Calcaneo-cuboid articulation, 724
 ligament, dorsal, 724, **721**
 inferior, **721**
 internal, 724, **721**
 long, 724
 short, 724

Calcaneo-scaphoid ligament, external, 720, 723, **721**
 inferior, 723, **721**

Calcaneum, dislocation, 739
 fracture, 757

Calculus, renal, 265
 Canal, Alcock's, 318

 anal, 338
 cervical, 368
 femoral, 569, **567**
 Hunter's, 577
 contents, **576**
 diagram, **573**
 termination, 599
 inguinal, 24, 80, **84, 85, 88**
 contents, 80
 obturator, 330, **57, 390**
 of Nuck, 372
 uterine, **365**

Capsular ligament, costo-vertebral, 528
 hip-joint, 701, **703**
 knee-joint, 710, **707**
 tibio-fibular, superior, 716
 Vide Individual articulations.

Capsule, Glisson's, 181
 of Bowman, 261
 of kidney, 256
 of prostate, 351
 suprarenal, 266, **223, 267**

Caput coli, 171
 gallinaginis, 352

Carcinoma of cervix of uterus, 367

Carcinoma of esophagus, 468
 Cardiac branch of gastric a., 270
 ganglion of Wrisberg, 452
 lymph-gland, 469
 nerve, pneumogastric cervical, 451

 sympathetic, **453**
 cervical, 451
 inferior, 452
 middle, 452
 superior, 451

 plexus of nerves, 289, 452
 deep, 455
 superficial, 452
 sympathetic, **286**

 vein, anterior, 483
 great, 483, **481, 490**
 posterior, 483, **481**

Carotid a., common, **477**
 left, 460, **481**
 anomalous origin, 460
 relations, 460
 right, **481**

Cartilage, ensiform, 22, **19**
 semilunar, knee-joint, 713
 xiphoid, **421**

Catheterization of female ureter, 385

Caudate lobe of liver, 234, **161**

Cavernous n., 357

Cavity, abdominal, 109
 boundaries, 110
 contents, 109, 110
 dissection, 106
 divisions, 110
 pelvic, 309
 male, contents, **312**
 outlets, 309
 peritoneal, 116. *Vide Peritoneal cavity.*
 thoracic, 436
 viscera, 436

Cavum prævesicale, 343

Cecum, 171, **138, 151, 174, 194, 312**
 nondescent, 172
 position, 38
 relations, 171
 topographic anatomy, 171
 types, 172

Celiac axis, 270, **223, 239, 245, 254, 271**
 origin, 24

 lymph-gland, 394
 plexus, 290

Cellulitis, pelvic, 317

Cervical branch of uterine a., 329, **331**

 canal, 368
 ganglion, **286**
 sympathetic, **453**
 pleura, 440
 sympathetic n., **286**

Cervix of bladder, 343
 of uterus, 367, **365**
 atresia, 367
 carcinoma, 367
 laceration, 367

Chambers, heart, 480

Chest, barrel-shaped, 398
 flat, 398
 funnel, 399

Cholecystenterostomy, 243

Cholecysto-duodenostomy, spontaneous, 222

Cholecystorrhaphy, 163

Cholecystotomy, 163

Cholelithiasis, 163

Chondro-sternal articulation, ligaments, 529
 ligament, anterior, 529
 posterior, 529

Chopart's amputation, 548, 761

Chordæ tendineæ, 488, **485**

Circular a. of cervix, 330

Circulation, fetal, 495

Circumflex a., external, 582, **583, 631**

 internal, 585, **583, 631**
 anastomosis, 585

 iliac a., deep, 71, 328, **77, 424**

 superficial, 46, 555, **44, 551**

 vein, deep, 284
 superficial, 46, **44, 551**

Claudius, fossa ovarii, 380

Clitoris, dorsal a., 334

Club-foot, 732

Coccygeal a., 641
 nerve, 358, **359, 362**
 plexus of n's, 358

Coccygeus m., 391, **349, 390**
 action, 391
 insertion, 391
 nerve supply, 391
 origin, 391

Colic a., 195, **148, 198, 199**
 anastomosis, 195
 left, 279, **198, 199**
 middle, 195, 278, **138, 194, 198**
 right, 195, 278, **138, 194**

Collateral circulation after ligation of femoral a., 779
 after ligation of femoral a., superficial, 780
 of iliac a., common, 324
 of popliteal a., 783
 digital a., **691**

Colles' ligament, 59

Colliculus seminalis, 352

Colon, 175
 accessibility to pressure, 179
 ascending, 175, **194**
 position, 38
 descending, 177, **194, 198**
 position, 38
 relations, 177
 hepatic flexure, 176
 transverse, 176, **183, 188, 194, 198**
 relations, 177

Colostomy, 219

Colporrhaphy, 379

Column of Bertini, 261, **259**

Columnæ carneæ, 488, **485, 490**

Comes nervi ischiadici a., 641
 phrenici a., 425, 450, **453**

Common bile duct, 181, 243, **161, 183, 227, 231, 239, 242, 271**

Common bile duct, course, 181
 surgery, 182
 duct of liver, 181, 243. *Vide*
 Common bile duct.
 extensor tendon, 591
 iliac v., 284, 336
 Communicans peronei n., 648,
 651, 663, **625, 649, 661,**
665, 673
 poplitei n., 648, **625, 649,**
661, 665, 673
 Communicating a. (foot), 618
 of leg, **673**
 Compression of abdominal aorta,
 24
 Condyle, femur, fracture, 753
 Congenital hernia, 90
 Conjoined tendon, 60, 72, **57, 84,**
85
 Constriction in hernia, femoral,
 571
 Contents of abdominal cavity,
 109, 110
 of inguinal canal, 80
 of mediastinum, anterior,
 439
 middle, 440
 posterior, 440
 superior, 439, **445**
 of pelvis, 310
 male, **312**
 of regions of abdomen, 112
 of sheath of rectus abdomi-
 nis m., 76
 of spermatic cord, 89
 Conus arteriosus, 488
 Cord, lumbo-sacral, 297, 358
 spermatic, 24, 89, **47, 57, 70,**
77, 84, 85, 424
 contents, 89
 coverings, 89
 formation, 90
 lipoma, 89
 Coronary a's, 458
 artery, 186, 277, **245, 490.**
Vide Gastric a.
 diseases, 483
 left, 458, 480, **485**
 right, 458, 480
 ligament of knee-joint, 713,
707
 of liver, 120, 131, 158,
160
 plexus of n's, 483, **355, 453**
 left, 455
 right, 455
 sympathetic, **286**
 sinus, 483, **481, 490**
 valve, 484
 vein, 186
 Corpora lutea, 380
 Corpus Arantii, 491, **493**
 spongiosum, a. of, 333
 Costal pleura, 440
 Costo-chondral articulation, 530
 Costo-stellate ligament, anterior,
 528
 Costo-sternal ligament, anterior,
 529
 posterior, 529
 Costo-transverse ligament, ante-
 rior, 529
 middle, 529

Costo-transverse ligament, poste-
 rior, 529
 Cotyloid ligament, 702, **703**
 Crease of groin, 23
 transverse, of abdomen, 22
 Cremaster m., 60, 65, 89, **54, 81,**
84, 85, 88
 action, 65
 blood supply, 65
 insertion, 65
 nerve supply, 65
 origin, 60
 Cremasteric a., 278, **57**
 branch of deep epigastric a.,
 79
 fascia, 65, 89. *Vide* Cremas-
 ter m.
 reflex, 65
 Crest of ilium, **19, 51**
 Cribriform fascia, 550
 Crises, gastric, 103
 Crucial anastomosis, 585, 641
 ligament, knee-joint, acces-
 sory band, 713
 anterior, 710, **707**
 posterior, 710, **707**
 Crura of diaphragm, 298, **525**
 Crural arch, 56, 530
 deep, 569
 structures in, 111
 branch of genito-crural n.,
 294, 560
 fascia, 602
 inflammation under, 606
 nerve, anterior, 297, 586, **287,**
355, 359, 579,
583
 incision to expose,
 791
 origin, 586
 septum, 105
 Crureus m., 591, **561**
 insertion, 591
 nerve supply, 591
 origin, 591
 Crypts of Lieberkühn, 205
 Cubo-cuneiform articulation, 727
 Cubo-metatarsal articulation, 728
 Cubo-scaphoid ligament, dorsal,
721
 Culdesac of Douglas, 120, 339
 Cutaneous a. of abdomen, ante-
 rior, **47**
 nerve, external, 294
 incision to expose,
 792
 nerve of abdomen, 46
 anterior, 49, **47**
 lateral, 49, **47**
 of thigh, external, 559
 internal, 559
 middle, 559
 nerves, leg, front, **603**
 of thigh, 556
 vein, femoral, external, **557**
 internal, **557**
 vessels, leg, front, **603**
 Cuvier, duct, 429, 449, 483
 left, 473
 Cyst of pancreas, 226
 of urachus, 106
 Cystic a., 186, **183**
 course, 186

Cystic duct, 182, 243, **161, 183,**
188, 223, 227, 231, 245,
271
 vein, 186
 Cystocele, 379

D.

Deltoid ligament, ankle, **721**
 ankle-joint, 718
 Delto-pectoral groove, 400
 Descending colon, 177, **194, 198**
 position, 38
 Descent of testicle, 90
 Development of femur, 746
 of fibula, 749
 of metatarsus, 749
 of patella, 749
 of phalanges of toes, 749
 of tarsus, 749
 of tibia, 749
 Diagram of abdominal viscera, **30,**
31, 34, 35, 113
 of heart, **405**
 of intercostal n., **67, 432,**
433
 of lungs, **34, 35, 113, 504,**
505
 of pelvic fascia, **319**
 of plexus of n's, lumbar, **291,**
359
 sacral, **291, 362**
 Diaphragm, 298, **143, 299, 520,**
521
 action, 302
 blood supply, 302
 central tendon, 301
 crura, 298, **525**
 insertion, 298
 nerve supply, 302
 openings, 301, 397
 origin, 298
 position, 27
 relations, 302
 structures piercing, 397
 Diaphragmatic a's, 518
 ganglion, **355**
 lymphatics, 435
 pleura, 440
 plexus of n's, 289
 Digital a., dorsal, **613**
 arteries of foot, 689
 Disarticulation, interphalangeal,
 758
 metatarso-phalangeal, 758
 mid-tarsal, 761
 tarso-metatarsal, 760
 Dislocation of ankle, 737
 of astragalus, 738
 of calcaneum, 739
 of femur, 735
 of fibula, 737
 of foot, 737
 of knee, 736
 of metatarsus, 739
 of patella, 736
 of phalanges of toes, 739
 of sternum, 414
 of tarsus, 739
 of tibia, backward, 736
 forward, 737
 head, 736
 lateral, 737

Dislocation, subastragaloid, 738
 Displacements of uterus, 368
 Dissection, abdomen, 41, **40**
 abdominal cavity, 100
 buttocks, 619
 foot, dorsum, 601
 sole, 680
 heart, 480, 484
 leg, back, 660
 front, 601
 mediastinum, superior, 444
 pericardium, 474
 thigh, back, 655
 front, 549
 lines, **554**
 Diverticulum, Meckel's, 171
 Divisions of abdominal cavity, 110
 Dorsal a. of clitoris, 334
 of penis, 333
 vein of penis, 337
 Dorsalis hallucis a., 618, **613**
 pedis a., 617, **609, 613**
 branches, 618
 course, 548
 ligation, 788
 guide, 607
 line for, 617
 relations, 617
 Dorsi-lumbar n., **359**
 Douglas' culdesac, 120, 339
 pouch, 120, 364, **365**
 semilunar fold, 65, 72, **74**
 Duct, bile, common, 181, 243,
 161, 183, 227,
 231, 239, 242,
 271
 course, 181
 surgery, 182
 structure, 243
 cystic, 182, 243, **161, 183,**
 188, 223, 227, 231, 245,
 271
 ejaculatory, 354
 hepatic, 182, 243, **161, 183,**
 188, 223, 227, 231,
 245, 271
 of Cuvier, 429, 483
 left, 473
 of pancreas, 225, 239, **242**
 of testis, 353
 of Wirsung, 225
 prostatic, 352
 spermatic, 89, 313
 thoracic, 469, 518, **465, 475,**
 481, 516, 520, 521
 Ducts of Gärtner, 378
 Ductus arteriosus, 495, **477**
 communis choledochus, 181,
 243. *Vide* Common bile
 duct.
 venosus, 496
 Duodenal glands, 205
 Duodeno-jejunal bend, 171, 222
 flexure, 171, 222, **148, 223**
 fossa, 149, **148**
 Duodenum, 170, 221, **143, 148,**
 194, 223, 239, 242
 divisions, 221
 first portion, **183**
 relations, 221
 surgery, 222
 suspensory ligament, 222
 ulceration, 205, 225

E.

Ejaculatory duct, 354, **349**
 Emphysema, 513
 Encysted hernia, 93, **92**
 Endothoracic fascia, 419, 435
 Ensiform cartilage, 22, **19**
 Enteric fever, appendicitis in,
 209
 Eparterial bronchus, 507
 Epididymal a., 278
 Epididymis, female, 383
 Epigastric a., deep, 24, 76, 327,
 70, 77, 133, 138,
 139, 312, 424
 line, **26**
 inferior, **77, 424**
 superficial, 45, 555, **44,**
 551
 superior, 76, 420, 426,
 70, 421
 lymphatic glands, 435
 plexus of n's, 289
 vein, deep, 284
 superficial, 46, **44, 551**
 Epispadias, 22
 Esophageal a's, 517
 branch of gastric a., 270, **183**
 plexus of n's, 450, **355**
 sympathetic, **286,**
 287
 Esophagus, 468, 518, **223, 465**
 blood supply, 469
 caliber, 468
 carcinoma, 468
 foreign bodies, 468
 nerve supply, 469
 relations, 468
 stricture, 468
 structure, 469
 Eustachian valve, 484, 496, **490**
 vein, **485**
 Excision, ankle-joint, 745
 astragalus, 745
 line of incision, **743**
 hip-joint, 739
 line of incision, **741**
 knee-joint, 740
 line of incision, **741,**
 743
 lower extremity, 739
 malleolus, external, line of
 incision, **741**
 metatarsal, 746
 os calcis, 745
 patella, 745
 phalanges of toes, 746
 Exstrophy of bladder, 22
 Extensor brevis digitorum m.,
 617, **609**
 action, 617
 insertion, 617
 nerve supply,
 617
 origin, 617
 longus digitorum m., 607,
 609
 action, 607
 insertion, 607
 nerve supply,
 607
 origin, 607
 hallucis m., **609, 613**

Extensor proprius hallucis m.,
 608
 action, 608
 insertion, 608
 nerve supply,
 608
 origin, 608
 tendon, common, 591
 tendons, thigh, fibrous ex-
 pansion, 706
 External oblique m., 50, **47, 51,**
 54, 64
 action, 50
 aponeurosis, 50, **47,**
 54, 64, 74
 openings, 55
 blood supply, 50
 derivatives, 56
 insertion, 50
 nerve supply, 50
 origin, 50
 spermatic fascia, 55
 Extraperitoneal connective tissue,
 104
 extravasation, 314
 Extravasation, extraperitoneal,
 314
 of urine, 45
 Extremity, lower, 530
 bones, development, 741
 excisions, 739
 joints, 701
 surface anatomy, 530
 markings, anterior,
 531
 external, **537**
 internal, **543**
 posterior, **540**

F.

Falciform ligament of thigh, 564,
 54, 81
 of liver, 131. *Vide* Sus-
 pensory ligament of
 liver.
 Fallopian tube, 314, 383, **315**
 blood supply, 383
 coats, 383
 lymphatics, 384
 nerve supply, 384
 removal, 384
 Fascia, abdomen, superficial, 42,
 44
 abdominal wall, deep, 49
 anal, 318
 cremasteric, 65, 89
 cribriform, 550
 crural, 602
 inflammation under, 606
 endothoracic, 419, 435
 gluteal, 620
 iliac, 303
 infundibuliform, 80, 89, **85**
 interabdominal, 59
 intercolumnar, 55, 89, **54, 81**
 intercostal, external, 416,
 435
 internal, 416, 435, **418**
 middle, 435
 ischio-rectal, 318
 lata, 560, **54, 81, 625**
 abscess beneath, 563

Fascia lata, division, 564
 hernia through, 564
 iliac portion, 564
 pubic portion, 564
 sartorial portion, 564
 leg, back, deep, 663
 deep transverse, **672**
 front, deep, 602
 superficial, 601
 lumbar, **74, 223**
 obturator, 318, **349, 390**
 of pyriformis, 317
 of Scarpa, 42
 pelvic, 317
 diagram, **319**
 phrenico-pleural, 442
 plantar, 683
 abscess, 684
 deep, **681**
 division, 549
 superficial, **681**
 popliteal, 647
 propria, 571
 recto-vesical, 310, 318
 spermatic, external, 55, 89.
 Vide Intercolumnar
 fascia.
 internal, 89
 middle, 89. *Vide* Cre-
 master m.
 thigh, back, 656
 superficial, 550
 transversalis, 79, **85**
 Femoral arch, 56
 artery, **57, 322, 576, 579**
 anomalies, 581
 common, 577, **583**
 branches, 581
 course, 536
 relations, 578
 deep, 582. *Vide* Pro-
 funda femoris a.
 branches, 582
 relations, 582
 ligation, 774, 779, **777**
 collateral circula-
 tion, 779
 superficial, 577
 branches, 581
 course, 536
 ligation, 779
 collateral circu-
 lation, 780
 line for, **776**
 relations, 578
 canal, 569, **567**
 hernia, 569, 570
 constriction, 571
 coverings, 571
 reduction, 536, 565
 taxis, 571
 ring, 536, **57**
 external, 564
 sheath, 566, **57**
 compartments, 569, **567**
 vein, 557, 586, **44, 54, 57,**
 81, 322, 551, 579
 common, **583**
 thrombosis, 586
 cutaneous external, **557**
 internal, **557**
 deep, 586
 superficial, 586

Femur, development, 746
 dislocation, 735
 fracture, condyle, 753
 extracapsular, 750
 intracapsular, 750
 shaft, 753, **751**
 trochanter, 750
 fractures, 750
 Fetal circulation, 495
 Fetus, foramen ovale, 487
 Fibro-cartilage, semilunar, knee-
 joint, internal, **707**
 Fibula, 546
 development, 749
 dislocation, 737
 fracture, 754
 head, 542
 nutrient a., 670
 Fibular artery, superior, 612
 Fissure of liver for ductus veno-
 sus, 233
 for gall-bladder, 233
 for inf. vena cava, 233
 longitudinal, 230, **231**
 transverse, 233
 umbilical, 233
 of prostate, 351
 Fistula, umbilical, 22
 urinary, umbilical, 106
 Flat-chest, 398
 Flat-foot, 731
 Flexor accessorius digitorum pedis
 m., 690
 action, 693
 insertion, 690
 nerve supply,
 693
 origin, 690
 brevis digitorum m., 684, **685**
 action, 687
 insertion, 687
 nerve supply,
 687
 origin, 684
 hallucis m., 694
 action, 694
 insertion, 694
 nerve supply,
 694
 origin, 694
 minimi digiti m., 694,
 691, 695
 action, 697
 insertion, 694
 nerve supply,
 697
 origin, 694
 longus digitorum m., 676,
 665, 673,
 691, 695
 action, 676, 693
 insertion, 676
 nerve supply,
 676
 origin, 676
 tendon, 693
 hallucis m., 676, **673,**
 677, 691,
 695
 action, 679
 insertion, 679
 nerve supply,
 679

Flexor longus hallucis m., origin,
 679
 tendon, 693
 muscles, thigh, blood supply,
 659
 nerve supply, 659
 Flexure of colon, hepatic, 176,
 174
 duodeno-jejunal, 171,
 222, **148, 223**
 sigmoid, 177, 313, **139,**
 198, 313
 digital examination,
 178
 relations, 178
 splenic, 176, **188**
 Floating kidney, 255, 265
 ribs, 414
 Fold, buttock, 541
 vestigial, Marshall, 473
 Foot, 730
 amputation, 757
 arch, lateral, 731
 longitudinal, 730
 transverse, 731
 arches, 730
 articulations, guides, 548
 club-, 732
 dislocation, 737
 dorsum, 617
 dissection, 601
 -drop, 617
 flat-, 731
 landmarks, bony, 548
 ligaments, **725**
 negro-heel, 731
 sole, 680
 abscess, 680
 dissection, 680
 fascia, superficial, 680
 muscles, 684
 surface markings, 547
 synovial cavities, section, **725**
 veins, 547
 Foramen of Winslow, 119, 129,
 191, 245
 hernia, 130
 ovale, 487, 496
 valve, **490**
 of vein of Galen, **485**
 Foramina papillariæ, 261
 Thebesii, 484, **485**
 Fossa, duodeno-jejunal, 149, **148**
 hernial, of peritoneum, 94,
 106
 ileo-cecal, 150, **154**
 ileo-colic, 149, **151**
 iliac, right, blood supply,
 209
 infraclavicular, 404
 inguinal, external, 106, **107**
 internal, 109, **107**
 middle, 106, **107**
 intersigmoid, 149
 ovalis, 487, **485**
 ovarîi of Claudius, 380
 subcecal, 150, **154, 155**
 Fossæ, peritoneal, 149
 Fracture, astragalus, 757
 calcaneum, 757
 femur, 750
 condyle, 753
 extracapsular, 750

Fracture, femur, intracapsular, 750
 shaft, 753, **751**
 fibula, 754
 patella, 753
 phalanges of toes, 757
 Pott's, 754
 metatarsus, 757
 malleolus, external, 754, **755**
 internal, 754, **755**
 ribs, 415
 sternum, 413
 tarsus, 757
 tibia, 754
 tibia and fibula, 757, **755**
 trochanter, great, 750
 Funicular a., 372
 process, 93
 hernia into, 93, **92**
 Fundus of uterus, 364
 position, 368
 Funnel-breast, 399
 Furrow, auriculo-ventricular, 480
 interventricular, 480
 thigh, 530

G.

Galen, vein, 483, 484
 foramen, **485**
 Gall-bladder, 158, 238, **133, 160, 161, 183, 188, 223, 231, 271**
 divisions, 238
 fissure for, 233
 position of, 28
 relations, 238
 structure, 238
 Gall-stones, 163
 Galvanization of phrenic n., 449
 Ganglia mesenterica, 290
 prostatica, 357
 semilunar, 289
 Ganglion, cardiac, of Wrisberg, 452, **286, 453, 475**
 cervical, **286**
 of sympathetic, **453**
 diaphragmaticum, 289, 302, 449, **286, 287, 355**
 impar, 354
 lumbar, **355**
 mesenteric, superior, **286, 287, 355**
 renal, **355**
 semilunar, **286, 355**
 thoracic, **286, 287, 355**
 Gärtner, ducts, 378
 Gastrectomy, 166
 Gastric a., 186, 270, **143, 183, 223, 245, 271**
 anastomosis, 186
 crises, 103
 lymphatic glands, inferior, 395
 superior, 395
 vein, 186, **223, 227, 271**
 Gastrocnemius m., 663, **609, 613, 625, 665**
 action, 664
 heads, 663
 insertion, 663
 nerve supply, 664
 III—51

Gastrocnemius m., origin, 663
 Gastro-colic omentum, 132, 164
 vessels in, 189
 Gastro-duodenal a., 185, 277, **183, 223, 245, 271**
 Gastro-enterostomy, 167, 255
 Gastro-epiploic, a., left, 189, 226, **183, 188, 245**
 right, 189, 277, **183, 188**
 vena comes, **183**
 lymphatic glands, 395
 vein, **223**
 left, 189, **188**
 right, 189, **188**
 vessels, **133**
 Gastro-epiploica dextra a., 277
 sinistra a., 277
 Gastro-hepatic omentum, 119, 164, **191**
 structures in, 181
 Gastro-phrenic ligament, 131, 135
 omentum, 164
 Gastrorrhaphy, 166
 Gastro-splenic omentum, 136, 164, 168, **188**
 structures in, 190
 Gastrostomy, 166, 248
 Gastrotomy, 166, 248
 Gemelli m's, **657**
 Gemellus m., inferior, 642, **631**
 insertion, 642
 nerve supply, 642
 origin, 642
 superior, 642, **631**
 insertion, 642
 nerve supply, 642
 origin, 642
 Genital branch of genito-crural n., 294
 Genito-crural n., 294, **57, 359**
 crural branch, 560
 Gimbernat's ligament, 59, **57**
 Glands, agminated, 205
 Brunner's, 205
 cardiac, 469
 duodenal, 205
 inguinal, superficial, 555
 intercostal, posterior, 527
 intestine, large, 208, 209
 small, 205
 lymphatic. *Vide* Lymphatic glands.
 mammary, supernumerary, 549
 mediastinal, posterior, 527
 superior, 469
 mesenteric, 141
 of Naboth, 369
 prostate, 313, 348, **341, 349**
 solitary, 205
 thymus, 444
 Glisson's capsule, 181
 Gluteal abscess, 620
 artery, 335, 628, **322, 331, 630, 635**
 course, 541
 ligation, 335, 628
 superior, **630**
 fascia, 620
 hematoma beneath, 620
 nerve, inferior, 363, 638, **359, 362, 639**

Gluteal nerve, superior, 363, 633, **359, 362**
 Gluteus maximus m., 623, **625, 657**
 action, 624
 bursæ, 623
 insertion, 623
 nerve supply, 624
 origin, 623
 relations, 624
 medius m., 627, **579, 625, 639, 657**
 action, 627
 insertion, 627
 nerve supply, 627
 origin, 627
 minimus m., 633
 action, 633
 insertion, 633
 nerve supply, 633
 origin, 633
 Gracilis m., 593, **561, 576, 579, 583, 625, 639, 657, 677**
 action, 594
 insertion, 593
 nerve supply, 594
 origin, 593
 Great omentum, 119, 132, 164, **133, 138, 139, 183, 188, 194, 198, 271**
 hernia, 56
 Groin, crease, 23
 Groove, delto-pectoral, 400
 Gubernaculum testis, 90
 Guide, ligation, dorsalis pedis a., 607
 tibial a., anterior, 605
 Gullet, 468, 518

H.

Hallux valgus, 733
 Hammer-toe, 733
 Hamstring, **668**
 muscles, 656
 tendons, division, 655
 Head of fibula, 542
 Heart, 479, **477, 481**
 apex-beat, 409
 auricle, 480, **485**
 left, **481, 490, 491**
 right, 484, **481**
 openings, 484
 capacity, 484
 chambers, 480
 dissection, 480, 484
 fat, 483
 furrow, auriculo-ventricular, 480
 interventricular, 480
 injuries, 492
 margo acutus, 479
 obtusus, 479
 position, 404, 479, **411**
 diagram, **405**
 valves, bicuspid, 492
 location, 409
 mitral, 492
 position, **405**
 semilunar, aortic, 492, **493**
 pulmonary, 491

Heart valves, tricuspid, 488, **485**
 veins, 483
 ventricle, 480, 491, **485**
 infundibulum, 488
 left, **481**
 right, 488, **481**
 vessels, **477**
 weight, 483
 wounds, 495
 Heister, valve, 238
 Hematoma beneath gluteal fascia, 620
 thigh, 564
 Hemorrhoidal a., middle, 329, **322, 331, 373**
 superior, 199, 279, **198, 322, 331, 373**
 anastomosis, 199
 nerve, inferior, 363
 plexus of n's, middle, 354 **355**
 sympathetic, **287**
 of veins, 337
 Hemorrhoids, 337
 Hemothorax, 443
 Henle, zona orbicularis, 701
 Hepatic a., 182, 270, 277, **161, 183, 188, 223, 227, 231, 239, 245, 267**
 branches, 185, 277
 duct, 182, 243, **161, 183, 188, 223, 227, 231, 245, 271**
 flexure of colon, 176, **174**
 position, 38
 relations, 176
 lymphatic glands, 394
 vein, 234, 284, **254**
 Hernia, 94
 adductor longus m., 601
 as guide, 594
 adiposé, 56, 89, 104
 Bassini's operation, 101
 congenital, 90
 operation, 99
 encysted, 93, **92**
 operation, 99
 femoral, 569, 570
 constriction, 571
 coverings, 571
 reduction, 536, 565
 taxis, 571
 infantile, 93, **92**
 operation, 99
 inguinal, 93
 direct, 94, 97
 coverings, 97
 operation, 99
 external, 94
 indirect, 94
 internal, 94
 oblique, 94, **95**
 coverings, 94
 incomplete, 98
 operation, 99
 operations, 98
 inguino-crural, 98
 intermuscular, 98
 into funicular process, 93, **92**
 into tunica vaginalis, 93, **92**
 intraparietal, 98
 labial, 98
 MacEwen's operation, 100

Hernia, obturator, 600
 operation, 600
 of great omentum, 56
 of lungs, 508
 omental, 132
 preperitoneal, 98
 reduction by taxis, 98
 retroperitoneal, of appendix, 175
 scrotal, 98
 straight, 98
 stricture of, 97
 through fascia lata, 564
 through foramen of Winslow, 130
 umbilical, 101
 acquired, 101
 congenital, 101
 coverings, 102
 infantile, 101
 operations, 102
 Hernial fossa of the peritoneum, 94, 106
 Herniotomy, obturator, 600
 Hesselbach's triangle, 97, 105
 Hey's amputation, 761
 ligament, 565
 Hiccup, 302
 Hilum of spleen, 168
 Hip-joint, 701, **703**
 abscess, 706
 amputation, 768
 racket incision, 773
 transfixion method, 774
 blood supply, 705
 excision, 739
 line of incision, **741**
 ligaments, 701
 movements, 705
 nerve supply, 705
 relations, 702
 section, **703**
 synovial membrane, 702
 synovitis, 705
 House-maid's knee, 591
 Hunter's canal, 577
 contents, **576**
 diagram, **573**
 termination, 599
 Hydronephrosis, 265
 Hydrops saccatus, 130
 Hydrothorax, 443
 Hymen, 379
 Hyparterial bronchus, 507
 Hypogastric artery, 106, 328, 496
 branch of ilio-hypogastric n., 49
 nerve, 293
 plexus of n's, 289, 354, **355**
 inferior, 354
 sympathetic, **287**
 Hypostatic congestion, 508
 Hysterectomy, 375

I.

Ileo-cecal fold, 150
 fossa, 150, **154**
 intussusception, 217
 valve, 210, **211, 214, 215**
 Ileo-colic a., 196, 278, **151, 194**
 anastomosis, 196

Ileo-colic a., branches, 196
 fold, 150, **151**
 fossa, 149, **151**
 intussusception, 217
 lymphatic glands, 396
 valve, 210
 Ileum, 170, 206
 wounds, 170
 Ileus, 170
 Iliac a., circumflex, superficial, 46, 555, **551**
 common, 323, **194, 198, 322**
 bifurcation, **26**
 ligation, 324
 line, 27, **26**
 right, 323
 external, 324, **151, 154, 322, 331**
 ligation, 386, **325, 387**
 line, 27, **26**
 relations, 327
 internal, 328, **322, 331**
 ligation, 324
 relations, 328
 branch of obturator a., 330
 of ilio-hypogastric n., 71
 fascia, 303
 divisions, 303
 fossa, right, blood supply, 209
 lymphatic glands, 393
 spine, anterior superior, 23
 vein, circumflex, deep, 284
 superficial, 46, **44, 551**
 common, 284, 336
 external, 284, 336
 internal, 336
 Iliacus m., 307, **223, 305, 579, 595**
 action, 308, 593
 blood supply, 307
 insertion, 307
 nerve supply, 307, 593
 origin, 307
 relations, 307
 Ilio-femoral band, 701, **703**
 Ilio-hypogastric n., 66, 293, 621, **47, 54, 70, 81, 88, 295, 359**
 hypogastric branch, 49
 Ilio-inguinal n., 49, 66, 293, 560, **47, 54, 70, 81, 88, 295, 359**
 Ilio-lumbar a., 334, **331**
 ligament, **223, 305**
 veins, 337, **525**
 Ilio-psoas bursæ, 593
 tendon, 593
 Ilio-tibial band, 545, 560
 Ilium, crest, **19, 51**
 spine, anterior superior, 535
 Imperforate rectum, 340
 Incision to expose crural n., anterior, 791
 to expose cutaneous n., external, 792
 to expose musculo-cutaneous n., 792, **776**
 to expose peroneal n., 791
 to expose popliteal n., internal, 791

Incision to expose saphenous n.,
 external or short, 792
 internal or long, 792
 to expose tibial a., anterior, **776**
 to expose tibial n., anterior, 791
 Infantile hernia, 93, **92**
 Infarct, pulmonary, 508, 513
 Inferior vena cava, 280, **161**
 Infra-clavicular fossa, 404
 Infracostal a., lateral, 425
 muscle, 419, **520**
 origin, 419
 relations, 419
 Infundibuliform fascia, 80, 89, **85**
 Infundibulum of ventricle of heart, 488
 Inguinal canal, 24, 80, **84, 85, 88**
 boundaries, 80
 contents, 80
 fossa, external, 106, **107**
 internal, 109, **107**
 middle, 106, **107**
 fossæ, 106, **107**
 hernia, 93
 direct, 94, 97
 external, 94
 indirect, 94
 internal, 94
 oblique, 94, **95**
 incomplete, 98
 lymphatic glands, 46
 superficial, 555
 Inguino-crural hernia, 98
 Injuries of stomach, 165
 Innominate a., 403, 459, **465, 475, 477, 481**
 ligation, 459
 vein, 447, **477**
 left, 447, **481**
 right, 447, **481**
 Interabdominal fasciæ, 59
 Interarticular ligament, costo-vertebral, 528
 Interauricular septum, 487
 Interchondral articulation, 530
 membrane, 416
 space, 22
 Intercolumnar fascia, 55, 89, **54, 81**
 Intercostal a., 426, 517, **465, 520**
 anterior, 425, **77, 421**
 aortic, 427, **424**
 superior, 427
 fascia, external, 416, 435
 internal, 416, 435, **418**
 middle, 435
 lymphatic glands, anterior, 436
 posterior, 436, 527
 lymphatics, 435
 membrane, anterior, 416, 435
 posterior, 416, 435
 muscle, 419, **418**
 action, 419
 nerve supply, 419
 external, 415, **77, 418, 424**

Intercostal a., external, insertion, 415
 origin, 415
 relations, 416
 internal, 416, **77, 418, 424**
 insertion, 416
 origin, 416
 relations, 416
 nerve, 66, 429, **70, 520**
 abdominal, 66
 diagram, **67, 432, 433**
 spaces, 415
 vein, 428, **465, 520, 521**
 superior, 428, 429, **477**
 Intercosto-humeral n., 430
 Intercuneiform articulation, 727
 Intermetatarsal articulation, 728, 729
 Intermuscular hernia, 98
 septum, thigh, **561**
 external, 563
 internal, 563
 posterior, 563
 Internal oblique m., 60, **54, 64, 70**
 action, 65
 aponeurosis, 60, **64**
 arching fibers, 60
 blood supply, 65
 insertion, 60
 nerve supply, 65
 origin, 60
 Interossei m., dorsal, 698
 plantar, 697
 Interosseous a., dorsal, 618
 (foot) dorsal, **613**
 ligament, 529
 calcaneo-astragaloid, 720
 tibio-fibular, inferior, 717
 membrane, leg, 716
 Interphalangeal articulation, 729
 blood supply, 729
 ligaments, 729
 movements, 729
 nerve supply, 729
 disarticulation, 758
 Intersigmoid fossa, 149
 Interspace, fourth, 400
 sixth, 400
 Interspinous ligament, 528
 Intertransversalis m., **305**
 Intertransverse ligament, 528
 Interventricular furrow, 480
 septum, **485**
 vein, posterior, 483, **481**
 Intervertebral substance, 528
 Intestinal lymphatics, 207
 lymphatic trunk, 395
 Intestine, large, 171
 blood supply, 210
 capacity, 180
 coats, 208
 divisions, 38
 glands, 208
 nerve supply, 210
 peculiarities, 179
 solitary glands, 209
 obstruction, 170
 small, 169, **138, 139, 194**
 blood supply, 205
 coats, 200
 divisions, 170

Intestine, small, glands, 205
 injuries, 207
 length, 169
 lymphatics, 207
 nerve supply, 206
 peculiarities, 179
 position, 169
 villi, 205
 wounds, 170
 Intraabdominal pressure, **110**
 Intraparietal hernia, 98
 Introitus vaginæ, 377
 Intussusception, 210
 ileo-cecal, 217
 ileo-colic, 217
 Inversion of uterus, 368
 Ischio-capsular band, 702
 Ischio-rectal fascia, 318
 Isthmus of uterus, 367

J.

Jejunum, 170, 206, **148**
 Joints, lower extremity, 701
 Vide Articulations.
 Jugular v., internal, **477, 481**
 right, **481**

K.

Kidney, 255, **223, 254, 267, 281**
 calyx, 261
 floating, 255, 265
 movable, 255, 265
 position, 38, 180
 relations, 180, **257**
 sections, **259**
 shape, 256
 sinus, 261, **263**
 structure, 261
 surfaces, 256
 veins, 262
 vessels, **267**
 wandering, 255
 Kidneys, blood supply, 262
 capsule, 256
 hilum, 261
 lymphatics, 262
 margins, 261
 nerve supply, 262
 position, 255
 weight, 256
 Knee, dislocation, 736
 flexor m's, **657**
 house-maid's, 591
 surface markings, 542
 synovial membrane, 545
 synovitis, 592
 Knee-joint, 706
 amputation, 764
 articular a., 651
 blood supply, 714
 bursæ, 715
 cartilage, semilunar, 713
 excision, 740
 line of incision, **741, 743**
 fibro - cartilage, semilunar, **707**
 ligament, capsular, **707**
 coronary, **707**
 crucial, posterior, **707**

Knee-joint, ligament, lateral, internal, 709
transverse, **707**
ligaments, 706
movements, 714
nerve supply, 714
pain, 715
posterior view, **711**
section, **707**
synovial membrane, 713

L.

Labial hernia, 98
Labium, pain, 638
Laceration of cervix of uterus, 367
Lacteals, 207
Landmarks, abdomen, 18, **19**
buttock, bony, 541
foot, bony, 548
of lungs, 409
of pleura, 410
of thorax, 399
Laryngeal n., inferior, 451
recurrent, 451, 453, **475**
Lateral ligament, ankle-joint, external, 718
knee-joint, external, 709, **711**
Latissimus dorsi m., **51, 64**
Lee's amputation, 764
Leg, amputation, 763, **765**
arteries, course, 547
back, deep muscles, **677**
dissection, 660
front, cutaneous nerves, **603**
vessels, **603**
dissection, 601
fascia, deep, 602
superficial, 601
interosseous membrane, 716
lymphatics, superficial, 601
surface markings, 546
veins, course, 547
Lesser omentum, 119, 135, **183**.
Vide Gastro-hepatic omentum.
structures in, 135
Levator ani m., 386, **349, 390**
insertion, 386
nerve supply, 386
origin, 386
Levatores costarum m., 419
insertion, 419
origin, 419
relations, 419
Lieberkühn, crypts, 205
Lieno-renal ligament, 131
Lieutaud, uvula, 346, **331**
Ligament, acro-uterine, **331**
annular, ankle-joint, 672
of ankle, anterior, 605
external, 606, 719
internal, 605, 718
anterior, ankle-joint, **721**
knee-joint, 709
appendiculo - ovarian, 142, **315**
astragalo-scaphoid, 723, **721**
broad, of uterus, 371, **373**
calcaneo-astragaloid, antero-internal, 720
external, 723

Ligament, calcaneo-astragaloid, internal, 723
posterior, 723
calcaneo-cuboid, dorsal, 724, **721**
inferior, **721**
internal, 724, **721**
long, 724
short, 724
calcaneo-scaphoid, external, 720, 723, **721**
inferior, 723, **721**
capsular. *Vide* Individual articulations.
costo-vertebral, 528
hip-joint, 701, **703**
knee-joint, 710, **707**
tibio-fibular, superior, 716
chondro-sternal, anterior, 529
posterior, 529
Colles', 59
coronary, knee-joint, 713, **707**
liver, 120, 131, 158, **160**
costo-stellate, anterior, 528
costo-sternal, anterior, 529
posterior, 529
costo - transverse, anterior, 529
middle, 529
posterior, 529
cotyloid, 702, **703**
crucial, knee-joint, anterior, 710, **707**
posterior, 710, **707**
accessory band, 713
cubo-scaphoid, dorsal, 721
deltoid, ankle-joint, 718, **721**
external lateral, ankle-joint, 718
gastro-phrenic, 131, 135
Gimbernat's, 59, **57**
Hey's, 565
ilio-lumbar, **223, 305**
interarticular, costo-vertebral, 528
interosseous, 529
calcaneo-astragaloid, anterior, 720
interspinous, 528
intertransverse, 528
lateral, knee-joint, external, 709, **711**
internal, 709
liver, 120
lieno-renal, 131, 168
of abdominal wall, triangular, 59, **54, 81, 84, 85**
of bladder, false lateral, 120
posterior, 120
peritoneal, 131
of liver, falciform, 131, **54, 81**
lateral, 131, 158, **160**
round, 106, 158, **133, 160, 161, 231**
suspensory, 131, 158, **133**
of ovary, 372
of penis, suspensory, 45, **47, 54, 81, 88**
of rectum, 323

Ligament of spleen, suspensory, 131, 168
of uterus, 370
broad, 120
false, 370
anterior, 120
lateral, 120
round, 372, **315**
true, 372
of Winslow, 659, 709
patellar, lateral, 710
peritoneal, 131
phreno-colic, 131, 168, 177
phreno-splenic, 131
plantar, deep, **699**
long, 724, **721, 725**
short, 724
posterior, knee-joint, 709, **711**
Poupart's, 56, 530, **19, 57, 64, 74, 84, 85, 88**
pubo-prostatic, 346
recto-coccygeal, **390**
recto-uterine, 371
sacro-lumbar, **305**
sacro-sciatic, great, **631, 657**
scapho-cuneiform, 724
stellate, 528
sternal, anterior, 530
posterior, 530
sterno-pericardiac, 470
inferior, **421**
supraspinous, 528
suspensory, of duodenum, 222
tibio-fibular, anterior, 716, 717
inferior, 717
interosseous, inferior, 717
superior, 716
posterior, 716, 717
superior, **711**
superior, 716
tibio-tarsal, 717
transverse, hip-joint, 702
knee-joint, 713, **707**
of toes, 683
tibio-fibular, inferior, 717
tubo-ovarian, 383
utero-ovarian, 372
utero-pelvic, 372
utero-sacral, 372
utero-vesical, false, 120
vertebral, 527
capsular, 528
common, anterior, 527
posterior, 527
vesico-uterine, 371
Ligamenta alaria, 710
subflava, 528
Ligaments of bladder, 346
false, 345, 447
lateral, 314
posterior, 120, 314
superior, 314
true, 323, 346
lateral, 345
superior, 345
of chondro-sternal articulation, 529
of foot, **725**
of hip-joint, 701

- Ligaments of knee-joint, 706
 of liver, 158
 of tarsus, **721**
- Ligamentum arcuatum externum, 298
 internum, 298
 cavæ sinistræ, 473
 latum pulmonis, 442, 444, 502
 mucosum, 710
 patellæ, 591, 709
 teres, 158, 702, **703**
- Ligation, dorsalis pedis a., 788
 guide, 607
 femoral a., 774, 779, **777**
 superficial, 779
 gluteal a., 335, 628
 iliac a., common, 324
 external, 386, **325, 387**
 internal, 324
 innominate a., 459
 peroneal a., 675, 784
 popliteal a., 653, 780
 pudic a., internal, 641
 sciatic a., 641, **643**
 tibial a., anterior, 787, **785**
 guide, 605
 posterior, 670, 783, **781**
- Limbus fossæ ovalis, 487
- Line, axillary, 404
 anterior, 404
 posterior, 404
 Bryant's, **534**
 for abdominal aorta, **26**
 for common iliac a., 27
 for deep epigastric a., **26**
 for dorsalis pedis a., 617
 for femoral a., superficial, **776**
 for greater curvature of stomach, 37
 for iliac a., common, **26**
 external, 27, **26**
 for lesser curvature of stomach, 37
 for peroneal a., **789**
 for popliteal a., **789**
 for scapula, 404
 for tibial a., anterior, 611, **776**
 posterior, **789**
 mammillary, 404
 mid-axillary, 404
 mid-sternal, 404
 Nélaton's, 535, **534**
 para-sternal, 404
 semilunar, **19**
 sternal, 404
 white, 318
- Linea alba, 18, 56, **19, 47, 51**
 semilunaris, 21, **47, 51**
- Lineæ albicantes, 18
 transversæ, 21, **19, 47, 51**
- Lipoma in Scarpa's triangle, 550
 in spermatic cord, 89
- Lisfranc's amputation, 760
 operation, 548
- Liver, 157, **133, 160, 183, 188, 223**
 abscess, 157
 blood supply, 237
 duct, common, 181, 243
- Liver, fissure for inferior vena cava, 233
 longitudinal, 230, **231**
 of ductus venosus, 233
 of gall-bladder, 233
 transverse, 233
 umbilical, 233
- ligament, 158
 coronary, 120, 131, 158, **160**
 falciform, 131, **54, 81**
 lateral, 120, 131, 158, **160**
 round, 106, 158, **133, 160, 161, 231**
 suspensory, 131, 158, **133**
- lobe, caudate, 234, **161**
 left, 234
 quadrate, 234
 right, 233
 Spigelian, 234, **161, 183, 191**
- lobes, 233
- lymphatics, deep, 237
 superficial, 234
- nerve supply, 237
 position of, 28
 relations, 157
 rupture, 157
 structure, 237
 surface, inferior, 230, **161, 231**
 posterior, 230
 superior, 230, **235**
 tuber omentale, **161, 231**
 vessels, 234
 weight, 230
- Lobe of liver, caudate, 234, **161**
 left, 234
 quadrate, 234
 right, 233
 Spigelian, 234, **161, 183, 191**
- Lobes of liver, 233
 of lungs, 502, **498, 499, 510, 511**
 of prostate, 351
- Location of abdominal viscera, 27
- Long saphenous v., **44**
- Loretta's operation, 166
- Lower, tubercle, 487
- Lumbar a., 279, **267**
 anastomosis, 279
 fascia, **74, 223**
 ganglion, **355**
 lymphatic glands, 394
 nerve, 290, **287, 355, 359**
 plexus of n's, 290, **295**
 branches, 293
 diagram, **291, 359**
- spine, 297
- vein, 283
 ascending, **525**
- Lumbo-sacral cord, 297, 358
- Lumbrical m., 693, **685, 691**
 action, 693
 insertion, 693
 nerve supply, 693
 origin, 693
- Lung, emphysematous, 513
 infarct, 508, 513
- Lungs, 501, **498, 499, 510, 511**
- Lungs, apex, 501
 base, 501
 blood supply, 508
 color, 508
 consistency, 508
 diagram, **34, 35, 113, 504, 505**
 hernia, 508
 landmarks, 409
 lobes, 502, **498, 499, 510, 511**
 nerve supply, 508
 position, **411**
 roots, 495, **445, 502**
 relations, 507
 weight, 507
 wounds, 508
- Lunulae, 491, **493**
- Luxation. *Vide* Dislocation.
- Lymphatic glands, cardiac, 469
 celiac, 394
 epigastric, 435
 gastric, inferior, 395
 superior, 395
 gastro-epiploic, 395
 hepatic, 394
 ileo-colic, 396
 iliac, 393
 inguinal, 46
 superficial, 555
 intercostal, anterior, 436
 posterior, 436, 527
 lumbar, 394
 mammary, internal, 436
 mediastinal, posterior, 527
 superior, 469
 mesenteric, 395
 meso-colic, 395
 of abdominal wall, 393
 of pelvic walls, 393
 pectoral, 435
 popliteal, 651
 psoas, 394
 sacral, 394
 splenic, 396
 thoracic wall, 435, 436
 visceral, 394
- Lymphatics, diaphragmatic, 435
 intercostal, 435
 of abdomen, 392
 superficial, 46
 of appendix, vermiform, 210
 of bladder, 347
 female, 385
 of Fallopian tube, 384
 of intestine, 207, 395
 small, 207
 of kidney, 262
 of leg, superficial, 601
 of liver, 234, 237
 of ovary, 380
 of pelvis, 392
 of pericardium, 473
 of pleura, 443
 of prostate, 352
 of spleen, 169
 of stomach, 167, 247
 of thoracic wall, 435
 of ureter, 348
 of uterus, 370
 of vagina, 378

M.

- McBurney's operation, 75, 217
point, 175
- MacEwen's operation for hernia, 100
- Malleolar a., 613
anterior, 612
internal, 612, 675
- Malleolus, external, fracture, 754, **755**
internal, fracture, 754, **755**
- Malpighian body, 261
pyramids, 261, **259**
- Mammary a., internal, 403, 420, **77, 421, 424, 481**
branches, 425
ligation, **401**
gland, supernumerary, 549
lymphatic glands, internal, 436
vein, internal, 426, **475, 477**
- Mammillary line, 404
- Marginal a., **481**
vein, 484
- Margo acutus, 479
obtusus, heart, 479
- Marshall, oblique v., 449
vein, 483
vestigial fold, 473
- Meckel's diverticulum, 171
- Mediastinal a., 425, 518, **421**
lymphatic glands, posterior, 527
pleura, 440
- Mediastinum, 436
abscess, 439
anterior, 439, **421, 438**
contents, 439
growths, 439
middle, 436, 470
contents, 440
posterior, 513, **465, 516, 520, 521**
contents, 440, 514
lymphatic glands, 527
superior, 436
contents, 439, **445**
dissection, 444
lymphatic glands, 469
- Medio-tarsal articulation, 723
- Meissner's plexus of n's, 206
- Membrane, interchondral, 416
intercostal, anterior, 416, 435
posterior, 416, 435
interosseous, leg, 716
obturator, **57, 305**
synovial, ankle-joint, 718
hip-joint, 702
knee-joint, 713
- Mesenteric a., inferior, 24, 199, 279, **143, 198, 223, 227, 267, 322**
branches, 199
superior, 24, 190, 229, 278, **138, 143, 194, 198, 223**
branches, 195
ganglion, superior, **286, 287, 355**
glands, 141
- Mesenteric lymphatic glands, 395
plexus of n's, inferior, 290, **355**
superior, 290, **355**
sympathetic, **287**
veins, inferior, 199, 229, **139, 148, 194, 198, 223**
superior, 195, 229, **194, 223**
- Mesentery, 136
attachments, 136, **143**
of appendix, 141
openings in, 141
structures in, 190
- Meso-appendix, 141, **154, 155**
- Meso colic lymphatic glands, 395
- Meso-colon, ascending, 142
descending, 142, **143**
transverse, 119
- Mesorchium, 90
- Meso-rectum, 149
- Meso-sigmoid, 120, 180, **143**
- Metatarsal a., 618
- Metatarso-phalangeal articulation, 729
disarticulation, 758
- Metatarsus, development, 749
dislocation, 739
excision, 746
fracture, 757
- Mid-axillary line, 404
- Mid-sternal line, 404
- Mid-tarsal disarticulation, 761
- Mitral valve, 492
- Moderator band, 488
- Mons veneris, 42
- Movable kidney, 255, 265
- Muscle, abductor hallucis, 687, **685, 691, 695**
minimi digiti, 687, **685, 691**
adductor brevis, 598, **583, 595**
longus, 594, **579**
magnus, 598, **561, 576, 583, 595, 625, 635, 657**
biceps, thigh, 656, **657**
coccygeus, 391, **349, 390**
cremaster, 60, 65, 89, **54, 81, 84, 85, 88**
crureus, 591, **561**
extensor brevis digitorum, 617, **609**
longus digitorum, 607, **609**
hallucis, **609, 613**
proprius hallucis, 608
external oblique, 50, **81**
flexor accessorius digitorum pedis, 690
brevis digitorum, 684, **685**
hallucis, 694
minimi digiti, 694, **691, 695**
longus digitorum, 676, **665, 673, 691, 695**
hallucis, 676, **673, 677, 691, 695**
- Muscle, gastrocnemius, 663, **609, 613, 625, 665**
gemellus, inferior, 642, **631**
superior, 642, **631**
gluteus maximus, 623, **625, 657**
medius, 627, **579, 625, 639, 657**
minimus, 633
gracilis, 593, **561, 576, 579, 583, 625, 639, 657, 677**
iliacus, 307, **223, 305, 579, 595**
infracostal, 419, **520**
intercostal, 419, **418**
external, 415, **77, 418, 424**
internal, 416, **77, 418, 424**
interossei, dorsal, 698
plantar, 697
intertransversalis, **305**
latissimus dorsi, **51, 64**
levator ani, 386, **349, 390**
levatores costarum, 419
lumbrical, 693, **685, 691**
oblique, external, 50
internal, 60, **54, 64, 70**
obturator externus, 645, **305, 635**
internus, 391, 600, 642, **391, 349, 657**
papillary, **485**
pectineus, 594, **579, 595**
pectoralis major, **47, 51**
minor, **51**
peroneus brevis, 615, **673, 677**
longus, 612, **609, 613, 668, 677**
tertius, 607, **613**
plantaris, 664, **649, 657, 673, 677**
popliteus, 676, **672, 677**
psoas magnus, 304, **254, 305, 322**
parvus, 308, **305**
pubo-vesical, 345
pyramidalis, 76, **70**
pyriformis, 633, **305, 390, 631, 657**
quadratus femoris, **305, 631**
lumborum, 308, **223, 305**
quadriceps extensor femoris, 588
femoris, 645, **657**
recto-coccygeal, 339
rectus abdominis, 75, **70, 74, 77**
femoris, 536, 588, **561, 576, 579**
sartorius, 535, 572, **576, 579, 657**
semimembranosus, 659, **576, 583, 625, 657**
semitendinosus, 656, **625, 657, 677**
serratus magnus, **47, 51, 70**
soleus, 664, **609, 665, 668**
sphincter ani, 208, 339
of bladder, internal, 345, **390**

Muscle, subcostal, 419
 suberureus, 592
 tensor fasciæ femoris, 535, 592, **579, 583**
 tibialis anticus, 606, **609**
 tendon, 547
 posticus, 679, **665, 673, 677**
 tendon, 546
 trachealis, 467
 transversalis, 71, **70, 74, 77, 85, 223, 424**
 transverse thoracic, 419
 transversus pedis, 697, **695**
 triangularis sterni, 419, **421, 438**
 vastus externus, 588, **561, 579, 583, 635**
 internus, 591, **561, 576, 579, 583**
 Muscles, gemelli, **657**
 hamstring, 656
 of buttock, 657
 of pelvis, 386
 of thigh, adductor, 593
 vasti, 536
 Muscularis mucosæ, 200
 of stomach, 247
 Musculi pectinati, 487
 papillares, 488
 Musculo-cutaneous n., **603**
 (leg), 616
 from peroneal, 602
 incision to expose, 792, **776**
 Musculo-phrenic a., 420, 426, **421**
 Musculus suspensorius duodeni, 222

N.

Naboth, glands, 369
 ovula of, 369
 Neck of bladder, 343
 Negro-heel, 731
 Nélaton's line, 535, **534**
 Nephrectomy, 265
 Nephrorrhaphy, 265
 Nerve, accessory obturator, 294, 597
 calcanean, internal, 676
 cardiac, of pneumogastric, cervical, inferior, 451
 superior, 451
 thoracic, 451
 of sympathetic, **453**
 cervical, 451
 inferior, 452
 middle, 452
 superior, 451
 cavernous, 357
 coccygeal, 358, **359, 362**
 communicans peronei, 648, 651, 663, **625, 649, 661, 665, 673**
 poplitei, 648, **625, 649, 661, 665, 673**
 crural, anterior, 297, 586, **287, 355, 359, 579, 583**
 incision to expose, 791

Nerve, crural, anterior, origin, 586
 cutaneous, external, 294
 incision to expose, 792
 of abdomen, 46
 anterior, 49, **47**
 lateral, 49, **47**
 of thigh, external, 559
 internal, 559, **576**
 middle, 559
 dorsi-lumbar, **359**
 ganglion of Wrisberg, **475**
 genito-crural, 294, **57, 359**
 crural branch, 560
 gluteal, inferior, 363, 638, **359, 362, 639**
 superior, 363, 633, **359, 362**
 hemorrhoidal, inferior, 363
 hypogastric, 293
 ilio-hypogastric, 66, 293, 621, **47, 54, 70, 81, 88, 295, 359**
 ilio-inguinal, 49, 66, 293, 560, **47, 54, 70, 295, 359**
 intercostal, 66, 429, **70, 520**
 abdominal, 66
 diagram, **432**
 intercosto-humeral, 430
 laryngeal, inferior, 451
 recurrent, 451, **453, 475**
 lumbar, **355, 359**
 musculo-cutaneous, **603**
 from peroneal, 602
 incision for, 792
 to expose, **776**
 (leg), 616
 obturator, 294, 597, **322, 359, 583**
 accessory, 294, **359**
 articular branch, 652
 branches, 598
 of Soemmering, 638
 perineal, of sacral, 357
 peroneal, 542, 546, 616, 648.
 Vide N., popliteal, external.
 incision to expose, 791
 phrenic, 449, 495, **453**
 galvanization, 450
 left, 449
 right, 449
 plantar, external, 689, **691**
 internal, 690, **691, 695**
 plexus, aortic, 290, **295, 355**
 brachial, **453**
 cardiac, 452
 deep, 455
 superficial, 452
 coccygeal, 358
 coronary, 483, **355, 453**
 left, 455
 right, 455
 diaphragmatic, 289
 epigastric, 289
 esophageal, 450, **355**
 gulae, 469
 hemorrhoidal, 354
 middle, **355**
 hypogastric, 289, 354, **355**

Nerve plexus, hypogastric, inferior, 354
 lumbar, diagram, 359
 Meissner's, 206
 mesenteric, inferior, 290, **355**
 superior, 290, **355**
 patellar, 559, **579**
 pelvic, 354
 phrenic, 289
 prevertebral, 289
 prostatic, 357
 pulmonary anterior, 455, **475**
 posterior, 455, **520**
 renal, 290, **355**
 sacral, 357, 358, **287, 295, 322, 355**
 diagram, **291, 362**
 visceral branch, 364
 sartorial, 560
 solar, 24, 289, **295**
 spermatic, 290
 subsartorial, 587, **576, 579**
 suprarenal, 289
 sympathetic, 354, **355**
 coronary, **286**
 esophageal, **286, 287**
 hemorrhoidal, **287**
 hypogastric, **287**
 mesenteric, **287**
 pelvic, **287**
 solar, **287**
 vesical, **287**
 uterine, 357
 vaginal, 357
 vesical, 354, **355**
 plexuses, pulmonary, 455
 pneumogastric, 450, 518, **286, 287, 355, 453**
 left, 450, **475**
 right, 450
 popliteal, external, 616, 648, **625, 639, 649, 665, 673**
 branches, 648
 internal, 648, **639, 649, 665, 673, 677**
 branches, 648
 incision to expose, 791
 pudendal, inferior, 638, **359**
 long, **625**
 pudic, 363, 642, **359, 362, 630, 631, 639**
 pulmonary, of pneumogastric, 451
 rami communicantes, **359**
 recurrent articular, 616
 sacral, 357, **355, 359, 362**
 saphenous, external or short, 602, 660, **661, 665**
 incision to expose, 792
 internal or long, 587, 602, 660, **557, 576, 579, 603, 661**
 incision to expose, 792

Nerve, saphenous, long, branch, articulating, 588
 muscular, 587
 sciatic, great, 358, 634, 659, **287, 355, 359, 362, 631, 635, 639, 643**
 stretching, 637, 788
 small, 363, 637, **359, 362, 625, 631, 643**
 splanchnic, great, 524, **286, 287, 295, 355, 520, 521**
 lesser, 524
 renal, 527
 small, **286, 287, 295, 520**
 smallest, 527, **355**
 sympathetic, abdominal, 284, **287**
 cervical, **286**
 thoracic, 524, **286**
 thoracic, **355**
 tibial, ant., 616, **603, 613**
 incision to expose, 791
 posterior, 675, 689, **665, 673, 677**
 to obturator internus m., 363, 638
 to pectineus m., 587
 to pyriformis m., 363
 to quadratus femoris m., 364, 638
 to sartorius m., 587
 Nerves, cutaneous, of leg, **603**
 of thigh, 556
 lumbar, 290, **287**
 of appendix, 210
 of pelvis, 354
 of spleen, 169
 pelvic, spinal, 357
 sympathetic, 354
 plantar, **691**
 subcutaneous, of thigh, **557**
 Nuck, canal, 372
 Nucleus pulposus, 528
 Nutrient a. of femur, 585
 of fibula, 670
 of tibia, 675

O.

Oblique m., external, 50, **81**.
 Vide External oblique m.
 Oblique m., internal, 60, **84, 88**.
 Vide Internal oblique m.
 Obstruction, intestinal, 170
 Obturator a., 330, 597, **322, 331, 583**
 anastomosis, 333, 597
 anomalous, 79
 branches, 330
 irregular, **57**
 canal, 330, **57, 390**
 externus m., 645, **305, 635**
 action, 646
 insertion, 646
 nerve supply, 646
 origin, 645
 fascia, 318, **349, 390**

Obturator, hernia, 600
 operation, 600
 internus m., 391, 600, 642, **349, 657**
 action, 391, 645
 blood supply, 391
 insertion, 391, 642
 nerve supply, 391, 645
 nerve to, 363
 origin, 391, 600, 642
 relations, 645
 membrane, **57, 305**
 nerve, 294, 597, **322, 359, 583**
 accessory, 294, 597, **359**
 articular branch, 652
 branches, 598
 Omega loop, 178
 Omenta, 131
 Omental hernia, 132
 tuberosity, 234
 Omentum, gastro-colic, 132, 164
 gastro-hepatic, 119, 164, **191**
 structures in, 181
 gastro-phrenic, 164
 gastro-splenic, 136, 164, 168, **188**
 structures in, 190
 great, 119, 132, 164, **133, 138 139, 183, 188, 194, 198, 271**
 hernia, 56
 lesser, 119, 135, **183**
 structures in, 135
 Vide Omentum, gastro-hepatic.
 Oophorectomy, 384
 Opening, saphenous, 536, **54, 81, 295**
 Openings in mesentery, 141
 of abdominal wall, 111
 of thorax, 396
 Operation, amputation at hip-joint, 768
 racket incision, 773
 transfixion method, 774
 Chopart's, 548, 761
 foot, 757
 Hey's, 761
 Lee's, 764
 Lisfranc's, 760
 Pirogoff's, 763
 Symes', 548, 762
 Teale's, 764
 thigh, **770**
 transfixion, 535
 toes, 757
 Wyeth's, 768
 appendicectomy, 217
 Barker's, 572
 Bassini's, for hernia, 101
 bronchotomy, 468
 colostomy, 219
 division, plantar fascia, 549
 excision, ankle-joint, 745
 astragalus, 745
 hip-joint, 739
 knee-joint, 740
 metatarsus, 746
 os calcis, 745
 patella, 745

Operation, excision, of phalanges of toes, 746
 for hernia, congenital, 99
 direct, 99
 encysted, 99
 infantile, 99
 inguinal, 98
 oblique, 99
 umbilical, 102
 for pes cavus, 733
 for talipes calcaneum, 734
 equino-varus, 732
 equinus, 734
 valgus, 733
 varus, 733
 gastrectomy, 166
 gastro-enterostomy, 167
 gastrorrhaphy, 166
 gastrostomy, 166
 gastrotomy, 166
 ligation, dorsalis pedis a., 788
 femoral a., 774, 779, **777**
 superficial, 779
 gluteal a., 628
 innominate a., 459
 peroneal a., 784
 popliteal a., 653, 780
 pudic a., internal, 641
 sciatic a., 641, **643**
 tibial a., anterior, 787, **785**
 posterior, 670, **783, 781**
 Lisfranc's, 548
 Loretta's, 166
 McBurney's, 75, 217
 MacEwen's, for hernia, 100
 oophorectomy, 384
 ovariectomy, 384
 paracentesis, pericardium, 474
 pylorotomy, 166, 251
 pyloroplasty, 166, 251, **249**
 splenectomy, 168
 stretching sciatic n., 637
 great, 788
 tenotomy, adductor hallucis, 549
 hamstring tendons, 655
 peroneal tendons, 547
 tendo Achilles, 546, 719
 tibialis anticus, 547
 posticus, 546
 thoracoplasty, 415, 444
 Witzel's, 248
 Organ of Rosenmüller, 383
 Orifice of stomach, cardiac, 37
 pyloric, 37
 of ureter, 346
 Os calcis, excision, 745
 uteri, external, 367
 internal, 369
 Oval foramen, 487
 Ovarian a., 278, **254**
 branches, 279
 vein, 283, **223, 227**
 Ovariectomy, 384
 Ovaries, 313, 379
 ligaments, 372
 Ovary, blood supply, 380
 lymphatics, 380
 nerve supply, 383

- Ovary, removal, 384
 Oviducts, 383
 Ovula of Naboth, 369
- P.**
- Pain in knee joint, 715
 in labium, 638
 in scrotum, 638
 Palpation, abdomen, 103
 abdominal, 18
 Pampiniform plexus of v's, 89.
Vide Spermatic veins.
 Pancreas, the, 225, **138, 143, 191, 194, 198, 223, 239, 242, 271**
 blood supply, 226
 cyst, 226
 duct, 225, **239, 242**
 nerve supply, 226
 position, 37
 relations, 225
 surgery, 226
 Pancreatic a., 185
 Pancreatica magna a., 226
 Pancreaticæ a., parvæ, 226
 Pancreatico-duodenal a., inferior, 195, 229, 278, **194, 223**
 anastomosis, 195
 superior, 185, 277, **223**
 anastomosis, 185
 vein, 185
 Panniculus adiposus, 42
 Papilla of Vater, **239, 242**
 Papillæ, renal, 261
 Papillary m., **484**
 Paracentesis abdominalis, 135
 pericardium, 474
 Para-sternal line, 404
 Parietes, abdominal, 41
 Parovarium, 383
 Pars membranacea septi, 492
 Passageway, scroto-abdominal, 42
 Patella, 542, **707**
 development, 749
 dislocation, 736
 excision, 745
 fracture, 753
 Patellar bursa, 591
 ligament, 591
 lateral, 710
 nerve plexus, 559, **579**
 Pectinate m., **485**
 Pectineus m., 594, **579, 595**
 action, 597
 insertion, 594
 nerve supply, 597
 nerve to, 587
 origin, 594
 relations, 597
 Pectoral lymphatic glands, 435
 Pectoralis major m., **47, 51**
 minor m., **51**
 Pelvic cavity, 309
 axis, 310
 boundaries, 110
 false, 309
 female, **315**
 inlet, 309
 male, contents, **312**
 outlets, 309
 true, 309
- Pelvic cavity, true, diameter, 309
 cellulitis, 317
 fascia, 317
 diagram, **319**
 nerves, 354
 spinal, 357
 sympathetic, 357
 peritoneum, 314
 plexus of n's, 354, **355**
 sympathetic, **287**
 walls, lymphatic glands, 393
 Pelvis, a's, 323
 contents, 310
 female, 310
 floor, muscles, **390**
 lymphatics, 392
 male, 310, **341**
 muscles, 386
 of ureter, 262
 position, 38
 veins, 336
 obstruction, 336
 viscera, 338
 Penis, dorsal a., 333
 vein, 337
 ligament, suspensory, 45, **47, 54, 81, 88**
 Perforating a's of thigh, 585
 artery, 425
 of foot, anterior, 689
 posterior, 688
 of thigh, first, 585, **583**
 fourth, 586
 second, 585, **583**
 third, 586, **583**
 Perforation of appendix, 142
 Pericardial a's, 517, **481**
 Pericarditis, 473
 reflex cough, 474
 Pericardium, 470, **445, 475**
 aspiration, **408**
 blood supply, 473
 dissection, 474
 lymphatics, 473
 nerve supply, 473
 paracentesis, 474
 pouches, 473
 relations, 473
 sinus, oblique, 473
 Perineal branch of sacral n., 357
 Perineorrhaphy, 379
 Perinephric abscess, 255
 Perineum, male, **341**
 Peri-pleuritic abscess, 444
 Perirenal fat, 105
 Peritoneal cavity, 116
 greater, 129
 lesser, 129
 covering of viscera, 130
 fossæ, 149
 ligament of bladder, 131
 ligaments, 131
 sac, 115
 Peritoneum, 112
 absorptive power, 115
 attachments, 116
 divisions, 116
 elasticity, 116
 fossa, hernial, 94, 106
 in fetus, 129
 parietal, 116
 pelvic, 314
 processes, 130
- Peritoneum, pus in, 116
 reflections, 119
 relation to bladder, 344
 traced vertically, **118**
 transverse course, 120, **121, 124, 125**
 vertical course, 119
 visceral, 116
 Peritonitis, localized, 115
 pain, 103
 Peroneal a., 670, **673, 677**
 anterior, 612, 670, **613, 673**
 anastomosis, 670
 branches, 670
 ligation, 675, 784
 line for, **789**
 posterior, 675, **673**
 nerve, 542, 546, 648, 616.
 Vide Popliteal n., external.
 incision to expose, 791
 tendons, 547
 tenotomy, 547
 Peroneus brevis m., 615, **673, 677**
 action, 615
 insertion, 615
 nerve supply, 615
 origin, 615
 longus m., 612, **609, 613, 668, 677**
 action, 615
 insertion, 615
 nerve supply, 615
 tendon, 698
 tertius m., 607, **613**
 action, 608
 nerve supply, 608
 origin, 607
 Pes cavus, 732
 operation, 733
 Petit triangle, 50, **51**
 Peyer's patches, 205, **204**
 Phalanges of toes, development, 749
 dislocation, 739
 excision, 746
 toe, fracture, 757
 Phrenic a., 270, **223, 267, 271, 281**
 anastomosis, 270
 superior, 425
 nerve, 449, 495, **453**
 galvanization, 450
 left, 449
 right, 449
 plexus of n's, 289
 vein, 284
 Phrenico-costal sinus, 442
 Phrenico-pleural fascia, 442
 Phreno-colic ligament, 131, 168, 177
 Phreno-splenic ligament, 131
 Phthisis, 508
 Pigeon-breast, 23, 398
 Pirogoff's amputation, 763
 Pit of the stomach, 21, 400
 Plantar arch, 688, 697, **699**
 arteries, **691**
 artery, external, 688, **691, 695**
 branches, 688

Plantar artery, external, course, 548
 relations, 688
 internal, 689, **681, 691, 695**
 course, 549
 fascia, 683
 abscess, 684
 deep, **681**
 division, 549
 superficial, **681**
 ligament, deep, **699**
 long, 724, **721, 724, 725**
 short, 724
 nerve, external, 689, **691**
 internal, 690, **691, 695**
 nerves, **691**
 Plantaris m., 664, **649, 657, 673, 677**
 action, 664
 insertion, 664
 nerve supply, 664
 origin, 664, **711**
 Pleura, 440
 aspiration, **408**
 blood supply, 443
 cervical, 440
 costal, 440
 diaphragmatic, 440
 landmarks, 410
 lymphatics, 443
 mediastinal, 440
 nerve supply, 443
 parietal, 440
 visceral, 440
 Pleural sac, 440
 cavity, 441
 space, supplemental, 442
 Pleurisy, 443
 Pleuritis, 443
 Plexus gulæ, 450, 469, **516, 520**
 of n's, aortic, 290, **295, 355**
 Auerbach's, 206
 brachial, **453**
 cardiac, 289, **452**
 deep, 455
 superficial, 452
 celiac, 290
 coccygeal, 358
 coronary, 483, **355, 453**
 left, 455
 right, 455
 diaphragmatic, 289
 epigastric, 289
 esophageal, 450, **355**
 hemorrhoidal, middle, 354, **355**
 hypogastric, 289, 354, **355**
 inferior, 354
 lumbar, 290, **295**
 diagram, **359**
 Meissner's, 206
 mesenteric, inferior, **355**
 superior, 290, **355**
 patellar, 559, **579**
 pelvic, 354
 phrenic, 289
 prevertebral, 289
 prostatic, 357
 pulmonary, 455
 anterior, **475**

Plexus of n's, pulmonary, posterior, **520**
 renal, 290, **355**
 sacral, 357, 358, **287, 295, 322, 355**
 diagram, **362**
 visceral branch, 364
 sartorial, 560
 solar, 24, 289, **295, 355**
 spermatic, 290
 subsartorial, 587, **576, 579**
 suprarenal, 289
 sympathetic, 354, **355**
 cardiac, **286**
 coronary, **286**
 esophageal, **286, 287**
 hemorrhoidal, middle, **287**
 hypogastric, 287
 mesenteric, inf., **287**
 pelvic, **287**
 solar, **287**
 vesical, **287**
 uterine, 357
 vaginal, 357
 vesical, 354, **355**
 of v's, hemorrhoidal, 337
 of Santorini, 385
 pampiniform, 89
 prostatic, 351
 uterine, 337
 vaginal, 337
 vesical, 337
 vesico-prostatic, 347
 of veins, vesico-prostatic, 337
 Plica semilunaris, 65
 ureterica, **331**
 Plicæ recti, 339
 Pneumatocele, 508
 Pneumogastric n., 450, 518, **286, 287, 355, 453, 475**
 left, 450
 right, 450
 Pneumonia, 508
 Pneumonitis, 508
 Pneumothorax, 443
 Point, McBurney's, 175
 Pons hepatis, 158, 233
 Popliteal abscess, 647, 654
 artery, 651, **649, 673, 707**
 aneurysm, 653
 branches, 651
 course, 545
 injury, 652
 ligation, 653, 780
 collateral circulation, 783
 line for, **789**
 fascia, 647
 lymphatic glands, 651
 nerve, external, 616, 648, **625, 639, 649, 665, 673**
 branches, 648
 internal, 648, **625, 639, 649, 665, 673, 677**
 branches, 648
 incision to expose, 791
 space, 646, **649, 657**

Popliteal space, boundaries, 545, 647
 bursæ, 654
 contents, 647
 dissection, 646
 vein, 652, **649, 673**
 vessels, surgery, 652
 Popliteus m., 676, **672, 677**
 action, 676
 insertion, 676
 nerve supply, 676
 origin, 676
 Portal system, veins, 189
 vein, 186, **161, 183, 188, 223, 227, 231, 239**
 radicles, 189
 relations, 186
 sinus, 189
 Posterior ligament, knee-joint, 709, **711**
 Pott's fracture, 754
 Pouch, Douglas', 120, 364, **365**
 pericardium, 473
 recto-vaginal, 120, 339, 364
 recto-vesical, 120, 313, 314, 339, 343
 utero-vesical, 120, **365**
 Poupart's ligament, 56, 530, **19, 57, 64, 74, 84, 85, 88**
 Precordial dulness, 409
 Prepatellar bursa, **707**
 Preperitoneal fat, 104
 hernia, 93
 Prevertebral plexuses of n's, 289
 Princeps hallucis a., **681, 699**
 Processus vaginalis, 90
 Profunda femoris a., 582, **583**.
 Vide Femoral a., deep.
 Prolapse of uterus, 368
 Prostate, 313, 348, **341, 349**
 blood supply, 352
 capsule, 351
 fissure, 351
 lobes, 351
 lymphatics, 352
 nerve supply, 352
 structure, 351
 Prostatic ducts, 352
 plexus of n's, 357
 of v's, 351
 sinus, 352
 urethra, 352
 Psoas abscess, 304, 563, 593
 lymphatic glands, 394
 magnus m., 304, **254, 305, 322**
 action, 307
 blood supply, 307
 insertion, 304
 nerve supply, 307
 origin, 304
 relations, 304
 muscle, **223, 583, 595**
 action, 593
 nerve supply, 593
 parvus m., 308, **305**
 insertion, 308
 nerve supply, 308
 origin, 308
 Pubes, spine, 23, 535
 Pubic branch of deep epigastric a., 79
 Pubo-femoral band, 701

Pubo-prostatic ligament, 346
 Pubo-vesical m., 345
 Pudendal n., inferior, 638, **359**
 long, **625**
 Pudic a., external, deep, 581
 superficial, 555, **44**,
 551
 internal, 333, 641, **322**,
 331, 631, 635
 branches, 334
 course, 541
 ligation, 641
 relations, 334
 nerve, 363, 642, **359, 362**,
 630, 631, 639
 vein, 337
 external, superficial, 44,
 551
 internal, 642
 Pulmonary a., 463, **453, 465**,
 475, 477, 485, 510,
 511, 521
 left, 464
 relations, 463
 right, 463, **481**
 branch of pneumogastric n.,
 451
 infarct, 513
 nerve plexus, 455
 anterior, **475**
 posterior, **520**
 opening, 491
 vein, **465, 475, 481, 490**,
 510, 511
 left, **481, 485**
 Pulsation of abdominal aorta, 24
 Pus in abdominal wall, 72
 in peritoneum, 116
 Pylorotomy, 166, 251
 Pyloric a., 185, **183, 223, 245**,
 271
 anastomosis, 185
 valve, 244
 vein, 185
 Pyloroplasty, 166, 251, **249**
 Pyopneumothorax, 443
 Pyothorax, 443
 Pyramidalis m., 76, **70**
 action, 76
 insertion, 76
 nerve supply, 76
 origin, 76
 Pyramids, Malpighian, 261, **259**
 Pyriformis fascia, 317
 muscle, 633, **305, 390, 631**,
 657
 action, 634
 insertion, 634
 nerve supply, 634
 nerve to, 363
 origin, 633

Q.

Quadrate lobe of liver, 234
 Quadratus femoris m., 645, **305**,
 631, 657
 action, 645
 insertion, 645
 nerve supply, 645
 nerve to, 364
 origin, 645
 relations, 645

Quadratus lumborum m., 308,
 223, 305
 action, 308
 blood supply, 308
 insertion, 308
 nerve supply, 308
 origin, 308
 relations, 308
 Quadriceps extensor femoris m.,
 588
 action, 592
 tendon, **579**

R.

Rachitic rosary, 399
 Rami communicantes, 289, **359**
 Receptaculum chyli, 207, 523,
 525
 Rectal tube, passing of, 179
 Rectocele, 379
 Recto-coccygeal ligament, **390**
 muscle, 339
 Recto-sigmoid curve, 178
 Recto-uterine ligaments, 371
 Recto-vaginal pouch, 120, 339
 Recto-vesical fascia, 310, 318
 pouch, 120, 313, 314, 339,
 343, 364
 Rectum, 313, 338, **312**
 ampulla, 338
 arteries, 339
 examination through, 340
 imperforate, 340
 length, 338
 ligament, 323
 position, 41
 relations, 338
 veins, 339
 walls, 338
 Rectus abdominis m., 75, **70, 74**,
 77
 action, 75
 blood supply, 75
 insertion, 75
 nerve supply, 75
 origin, 75
 sheath, 65, **70, 74**
 contents, 76
 tendinous intersec-
 tions, 75
 femoris m., 536, 588, **561**,
 576, 579
 insertion, 588
 nerve supply, 588
 origin, 588
 relations, 588
 Recurrent articular n., 616
 laryngeal n., 451, **453, 475**
 tibial a., 612
 anterior, **613**
 posterior, 611
 Reflex cremasteric, 65
 Region of precordial dulness, 409
 Regions of abdomen, 111
 contents, 112
 Relation of peritoneum to blad-
 der, 344
 Relations of abdominal aorta, 269
 viscera, 150
 of bladder, 346
 of cecum, 171
 of colon, descending, 177

Relations of colon, transverse,
 177
 of diaphragm, 302
 of duodenum, 221
 of gall-bladder, 238
 of hepatic flexure, 176
 of iliac a., common, left, 323
 right, 323
 external, 327
 internal, 328
 of iliacus m., 307
 of infracostal m., 419
 of intercostal m., external,
 416
 internal, 416
 of kidney, 180, **257**
 of liver, 157
 of lungs, roots, 507
 of pancreas, 225
 of portal v., 186
 of psoas magnus m., 304
 of pudic a., internal, 334
 of quadratus lumborum m.,
 308
 of rectum, 338
 of sigmoid flexure, 178
 of spleen, 167
 of stomach, 164
 of vagina, 378
 Renal a., 24, 278, **254, 281**
 calculus, 265
 ganglion, **355**
 papillæ, 261
 plexus of n's, 290, **355**
 splanchnic n., 527
 vein, 283, **227, 267, 281**
 Retroflexion of uterus, 368
 Retro-peritoneal hernia of appen-
 dix, 175
 viscera, 130
 Retroversion of uterus, 368
 Retzius' space, 343
 Rib, fifth, 400
 first, 400
 second, 400
 sixth, 400
 Ribs, 414
 elasticity, 414
 floating, 414
 fracture, 415
 true, 414
 Rider's bone, 600
 sprain, 600
 Ring, abdominal, external, **23**,
 55, 51, 57
 pillars, 55
 internal, 23, 80
 structures in, 111
 femoral, 536, **57**
 external, 564
 umbilical, 56
 Root of lungs, 495
 Roots of lungs, 502
 Rosary, rachitic, 399
 Rosenmüller, organ of, 383
 Round ligament of liver, 106, 158,
 133, 160, 161, 231
 of uterus, 372, **315**
 Rupture of bladder, 317, 347
 of liver, 157
 of sartorius m., 572
 of spleen, 168
 of tendo Achillis, 719

S.

- Sac, peritoneal, 115
 pleural, 440
 landmarks, 410
 Sacculi of bladder, 345
 Sacral a., 335, **331**
 lateral, 335
 middle, 279, **322**
 lymphatic glands, 394
 nerve, 357, **355, 349, 362**
 plexus of nerves, 357, 358,
 287, 295, 322,
 355
 diagram, **291, 362**
 visceral branch, 364
 vein, middle, 337
 Sacro-lumbar ligament, **305**
 Sacro-sciatic ligament, great, **631,**
 657
 Salpingectomy, 384
 Santorini, plexus of v's, 385
 Saphenous n., external or short,
 602, 660, **661,**
 665
 incision to ex-
 pose, 660, 792
 internal or long, 587, 602,
 660, **557,**
 576, 579,
 603, 661
 branch, articu-
 lating, 588
 branch, muscu-
 lar, 587
 incision to ex-
 pose, 792
 opening, 536, 564, **54, 81,**
 295, 567
 vein, external or short, 660,
 661, 665
 origin, 601
 internal or long, 556,
 660, **44, 54,**
 551, 557,
 567, 603,
 661
 origin, 601
 varicose, 556
 Sartorial n. plexus, 560
 Sartorius m., 535, 572, **576, 579,**
 657
 action, 577
 blood supply, 577
 insertion, 572, **576**
 nerve to, 587
 origin, 572
 rupture, 572
 Scapho-cuboid articulation, 724
 Scapho-cuneiform articulation,
 724
 Scapula line, 404
 Scarpa's fascia, 42
 triangle, 536
 boundaries, 565
 contents, 565
 lipoma, 550
 surgical importance, 566
 Sciatic a., 334, 638, **322, 631,**
 635
 anastomosis, 638, 641
 branches, 641
 ligation, 641, **643**
 Sciatic nerve, great, 358, 634, 659,
 287, 355, 359,
 362, 631, 635,
 639, 643
 stretching, 788
 small, 363, 637, **359,**
 362, 625, 631, 643
 stretching, 637
 vein, 642
 Sciatica, 637
 Scrobiculus cordis, 164, 400
 Scrotal hernia, 98
 Scroto-abdominal passageway, 42
 Scrotum, pain, 638
 Section, transverse, abdominal
 wall, **61**
 Semilunar cartilage, knee-joint,
 713
 fibro-cartilage, knee-joint,
 internal, **707**
 fold of Douglas, 65, 72, **74**
 ganglia, 289
 ganglion, **286, 355**
 lines, **19**
 valves, aortic, 492, **493**
 pulmonary, 491
 Semimembranosus m., 659, **576,**
 583, 625, 657
 action, 659
 insertion, 659
 nerve supply, 659
 origin, 659
 Seminal vesicle, 352, **349**
 blood supply, 353
 function, 353
 nerve supply, 353
 vesicles, 313
 Semitendinosus m., 656, **625,**
 657, 677
 action, 659
 nerve supply, 659
 origin, 656
 Septa, intermuscular, thigh, **561**
 Septum atriorum, 487
 auricular, **490**
 crurale, 105
 interauricular, 487
 intermuscular, thigh, exter-
 nal, 563
 internal, 563
 posterior, 563
 interventricular, **485**
 ventriculorum, 492
 Serratus magnus m., **47, 51, 70**
 Sheath, femoral, 566, **57**
 compartments, 569, **567**
 of rectus abdominis m., 65,
 70, 74
 Shin, 546
 Shoulder-hip pains, 237
 Sibson, vestibule, 492
 Sigmoid a., 199, 279, **198**
 flexure, 177, 313, **139, 198,**
 313
 course, 179
 digital examination, 178
 position, 38
 relations, 178
 Sinus, aorta, 456
 coronary, 483, **481, 490**
 oblique, of pericardium, 473
 of portal v., 189
 of Valsalva, 491, **493**
 Sinus, phrenico-costal, 442
 pocularis, 352, **341**
 prostatic, 352
 Sinuses of Valsalva, 457
 Skin of abdomen, 18
 Small intestine, **134**
 peculiarities, 179
 position, 41
 Soemmering, n. of, 638
 Solar plexus of n., 24, 289, **295,**
 355
 branches, 289
 sympathetic, **287**
 Sole of foot, 680
 Soleus m., 664, **609, 665, 668**
 action, 664
 heads, 664
 insertion, 664
 nerve supply, 664
 origin, 664
 Solitary glands, 205
 Space of Retzius, 343
 popliteal, 646, **649, 657**
 boundaries, 545, 647
 bursæ, 654
 contents, 647
 dissection, 646
 Spermatic a., 89, 278, **254, 267**
 branches, 278
 cord, 24, 89, **47, 57, 70, 77,**
 84, 85, 424
 contents, 89
 coverings, 89
 formation, 90
 lipoma, 89
 duct, 89, 313
 fascia, external, 55, 89. *Vide*
 Intercolumnar fascia.
 internal, 89
 middle, 89. *Vide* Cre-
 master m.
 plexus of n's, 290
 vein, 89, 283, **223, 227**
 Sphincter ani m., internal, 208,
 339
 muscle of bladder, internal,
 345, **390**
 vesicæ m., **390**
 Spigelian lobe of liver, 234, **161,**
 183, 191
 Spine, iliac, anterior superior, 535
 pubic, 23, 535
 Splanchnic n., great, 524, **286,**
 287, 295, 355, 520,
 521
 lesser, 524
 renal, 527
 small, **286, 287, 295,**
 520
 smallest, **527, 355**
 Spleen, 167, **188, 191, 223**
 blood supply, 169
 hilum, 168
 ligament, suspensory, 131
 lymphatics, 169
 nerves, 169
 position of, 37
 relations, 167
 rupture, 168
 surface, external, **274**
 internal, **275**
 surfaces, 168
 suspensory ligament, 168

- Spleen, weight, 37
 Splenectomy, 168
 Splenic a., 226, 277, **143, 188, 191, 223, 227, 239, 245, 267, 271, 275**
 branches, 226, **188**
 flexure, 176, **188**
 position, 38
 lymph-gland, 396
 vein, 226, 229, **188, 191, 194, 198, 223, 239, 275**
 Stellate ligament, 528
 Steppage gait, 617
 Sternal a., 425, **421, 438**
 ligament, anterior, 530
 posterior, 530
 line, 404
 Sterno-clavicular junction, 400
 Sterno-pericardiac ligament, 470
 inferior, **421**
 Sternum, 413
 congenital defects, 414
 dislocation, 414
 fracture, 413
 Stomach, 163, **133, 183, 194, 245, 271, 355**
 arteries, **245**
 blood supply, 167, 247
 coats, 244
 incision to expose, 166
 injuries, 165
 lymphatics, 167, 247
 orifice, cardiac, 37
 pyloric, 37
 pit, 21, 400
 position of, 37
 relations, 164
 structure, 244
 surgical anatomy, 247
 veins, 247
 Straight hernia, 98
 Stretching sciatic n., 637
 great, 788
 Stricture, esophagus, 468
 Structures in gastro-hepatic omentum, 181
 in gastro-splenic omentum, 190
 in lesser omentum, 135
 in mesentery, 190
 piercing diaphragm, 397
 Subastragaloid dislocation, 738
 Subcecal fossa, 150, **154, 155**
 Subchondral angle, 22
 Subclavian a., **77, 424, 453, 477**
 left, 460, **475**
 relations, 460
 right, **481**
 vein, **477, 481**
 left, **475, 481**
 right, **481**
 Subcostal angle, 22
 artery, 517
 muscle, 419
 vein, 429
 Subcrureus bursa, 715
 muscle, 592
 action, 592
 nerve supply, 592
 Subgluteal triangle, 624
 Subperitoneal fat, 104
 Subsartorial plexus of n's, 587, **576, 579**
- Suprarenal a., 24, 298
 inferior, 278, **254, 281**
 middle, 278, **254, 281**
 superior, 278, **254, 281**
 body, **254, 281**
 capsule, 266, **223, 267**
 blood supply, 269
 nerve supply, 269
 plexus of n's, 289
 vein, 269, 284, **227**
 Supraspinous ligament, 528
 Sural a's, 652
 artery, external, **649**
 internal, **649**
 ankle, 546
 extremity, lower, 530
 anterior, **531**
 external, **537**
 internal, **543**
 posterior, **540**
 foot, 547
 knee, 542
 leg, 546
 Surface markings of abdomen, 18
 thigh, 530
 Surgery of duodenum, 222
 of pancreas, 226
 of popliteal vessels, 652
 Suspensory ligament of duodenum, 222
 of liver, 131, 158, **133**
 of penis, 45, **47, 54, 81, 88**
 of spleen, 131, 168
 Symes' amputation, 548, 762
 Sympathetic n., abdominal, 284, **287**
 cervical, **286**
 pelvic, 357
 thoracic, **286**
 plexus of n., 354, 355
 coronary, **286**
 esophageal, **286, 287**
 hemorrhoidal, **287**
 hypogastric, **287**
 mesenteric, **287**
 pelvic, **287**
 solar, **287**
 vesical, **287**
 of n's, cardiac, **286**
 Synovial membrane, ankle-joint, 718
 hip-joint, 702
 knee-joint, 545, 713
 Synovitis, hip-joint, 705
 knee, 592
- T.**
- Tabes mesenterica, 141
 Talipes arcuatus, 683
 calcaneus, 732
 operation, 734
 equino-varus, 732
 operation, 732
 equinus, 732
 operation, 734
 planus, 683
 valgus, 732
 operation, 733
 varus, operation, 733
 Tapping bladder, 344
- Tarsal a., 618
 articulation, 720
 Tarso-metatarsal articulation, 727, 728
 disarticulation, 760
 Tarsus, development, 749
 dislocation, 739
 fracture, 757
 ligaments, **721**
 Taxis in hernia, femoral, 571
 Teale's amputation, 764
 Tendo Achillis, 546, 663, 664, **665, 668**
 division, 669
 formation, 664
 insertion, 669
 rupture, 719
 tenotomy, 546, 719
 patellæ, 591, 709, **579**
 relations, 545
 Tendon, adductor hallucis, tenotomy, 549
 central, of diaphragm, 301
 common extensor, 591
 conjoined, 60, 72, **57, 84, 85**
 flexor longus digitorum, 693
 hallucis, 693
 ilio-psoas, 593
 peroneal, 547
 peroneus longus, 698
 quadriceps extensor, **578**
 tibialis anticus, 547
 posticus, 546
 guide, 546
 muscle, 698, **699**
 Tenotomy, adductor hallucis tendon, 549
 hamstring tendons, 655
 peroneal tendons, 547
 tendo Achillis, 546, 719
 tibialis anticus tendon, 547
 posticus tendon, 546
 Tensor faciae femoris m., 535, 592, **579, 583**
 action, 593
 insertion, 592
 origin, 592
 nerve supply, 593
 Testes muliebres of Galen, 379
 Testicle, descent, 90
 duct, 353
 Testicular a., 279
 Thebesius, foramen, **485**
 foramina, 484
 valve, 483, 484
 Thigh, 530
 abscess, 563
 adductor m's, 593
 amputation, 767, **770**
 lower third, **770**
 transfixion, 535
 upper third, **770**
 back, dissection, 655
 fascia, 656
 compartments, 563
 dissection, lines, **554**
 extensor tendons, fibrous expansion, 706
 front, 549
 cutaneous n's, 556
 dissection, 549
 fascia, superficial, 550

Thigh, front, nerve, subcutaneous, **557**
 vessels, subcutaneous, **557**
 superficial, 555
 furrows, 530
 hematoma, 564
 muscles, action, 659
 psoas abscess, 563
 surface anatomy, 530
 transverse section, **770, 771**
 Thoracentesis, 428, 443
 Thoracic aorta, 456, 514, **465, 481**
 aneurysm, 458
 branches, 517
 descending, 457
 divisions, 456
 relations, 514
 artery, long, **77, 424**
 superior, **424**
 cavity, 436
 viscera, 436
 duct, 469, 518, **465, 475, 481, 516, 520, 521**
 ganglion, **286, 287, 355**
 muscle, transverse, 419
 nerve, **355**
 sympathetic, 524, **286**
 wall, lymphatics, 435
 lymphatic glands, 435, 436
 Thoracoplasty, 415, 444
 Thorax, 396
 barrel-shaped, 398
 cross-section, 461, **471**
 diameters, 397
 expansion, 398
 female, 398
 flat, 398
 funnel breast, 399
 inlet, 396
 joints, 527
 landmarks, 399
 normal, 398
 opening, 396
 outlet, 397
 pigeon-breast, 398
 posterior surface, landmarks, 403
 surface anatomy, 399
 unilateral changes, 399
 wall, 413
 Thrombosis, femoral v., common, 586
 Thymic a., 425
 Thymus gland, 444
 Thyroid v., **481**
 Thyroidea ima a., 459
 Tibia and fibula, fracture, 757, **755**
 development, 749
 dislocation, 737
 fracture, 754
 head, dislocation, 736
 nutrient a., 675
 tuberosity, external, 545
 internal, 545
 Tibial a., anterior, 608, **673, 677**
 branches, 611
 course, 547
 incision to expose, **776**
 injuries, 611

Tibial a., anterior, ligation, 787, **785**
 guide, 605
 line for, 611, **776**
 relations, 611
 posterior, 669, 688, **665, 673**
 bifurcation, **699**
 branches, 670
 course, 547
 ligation, 670, 783, **781**
 line for, 669, **789**
 recurrent, 612
 anterior, **613**
 posterior, 611
 nerve, anterior, 616, **603, 613**
 incision to expose, 791
 posterior, 675, 689, **665, 673, 677**
 vein, posterior, 669
 Tibialis anticus m., 606, **609**
 action, 607
 insertion, 606
 nerve supply, 607
 origin, 606
 relations, 606
 tendon, 547
 posticus m., 679, **665, 673, 677**
 action, 679
 insertion, 679
 nerve supply, 679
 origin, 679
 tendon, 546, 698, **699**
 tendon, guide, 546
 tenotomy, 546
 Tibio-fibular articulation, blood supply, 717
 inferior ligaments, 717
 movements, 717
 nerve supply, 717
 superior, 716
 ligaments, 716
 ligament, anterior, 716, 717
 posterior, 716, 717
 superior, **711**
 transverse, inferior, 717
 Tibio-tarsal ligament, 717
 Toes, 733
 amputation, 757
 phalanges, development, 749
 transverse ligaments, 683
 Trachea, 464, **465, 498, 499, 520, 521**
 blood supply, 467
 nerve supply, 467
 relations, thoracic, 464
 structure, 464
 Tracheal tug, 467
 Trachealis m., 467
 Transversalis fascia, 79, **85**
 muscle, 71, **70, 74, 77, 85, 223, 424**
 action, 72
 aponeurosis, **74**
 blood supply, 72
 insertion, 71
 nerve supply, 72
 origin, 71

Transverse colon, 176, 177, **183, 188, 194, 198**
 position, 38
 ligament, hip-joint, 702
 knee-joint, 713, **707**
 tibio-fibular, inferior, 717
 ligaments of toes, 683
 thoracic m., 419
 vein, 447
 Transversus pedis m., 697, **695**
 action, 697
 insertion, 697
 nerve supply, 697
 origin, 697
 Triangle, Bryant's, 535, **534**
 Hesselbach's, 97, 105
 of Petit, 50, **51**
 of Scarpa, boundaries, 565
 contents, 565
 lipoma, 550
 surgery, 566
 Scarpa's, 536
 subgluteal, 624
 Triangular ligament of abdominal wall, 59, **54, 81, 84, 85**
 Triangularis sterni m., 419, **421, 438**
 insertion, 419
 origin, 419
 Tricuspid valve, 488, **485**
 Trigone, vesical, 346, **331**
 Trochanter, great, 535
 fracture, 750
 Tube, Fallopian, 314, 383, **315**
 rectal, passing, 179
 Tuber omentale (liver), **161, 231**
 Tubercle, adductor, 545, 599
 of Lower, 487
 Tuberosity, omental, 234
 tibia, external, 545
 internal, 545
 Tubo-ovarian ligament, 383
 Tubules, uriniferous, 261
 Tunica vaginalis, 90
 hernia into, 93, **92**
 Tympanites, 206
 Types of cecum, 172

U.

Ulcer of duodenum, 205, 225
 Umbilical a., 328
 fistula, 22
 urinary, 106
 hernia, 101
 vein, 496
 Umbilicus, 22
 fibrous ring, 56
 Urachus, 106, 340, **107, 133, 315**
 cysts, 106
 Uretal a., 278
 Ureter, 262, 347, **223, 227, 254, 267, 281, 349, 373**
 blood supply, 262, 348
 coats, 262
 female, catheterization, 385
 lymphatics, 348
 nerve supply, 265, 348
 orifice, 346
 pelvis, 38, 262

Ureter, veins, 262
 Urethra, female, 385
 blood supply, 386
 nerve supply, 386
 prostatic, 352
 Urethral crest, 352
 Urine, extravasation, 45
 Uriniferous tubules, 261
 Uterine a., 329, **331, 373**
 plexus of n's, 357
 of veins, 337
 vein, 370
 Utero-ovarian ligaments, 372
 Utero-pelvic ligaments, 372
 Utero-sacral ligaments, 372
 Utero-vesical false ligament, 120
 pouch, 120, **365**
 Uterus, 364, **373**
 anteflexion, 368
 anteversion, 368
 blood supply, 370
 body, 364
 cavity, 369
 broad ligament, 120
 canal, **365**
 cervical, 368
 cavity, 368
 cervix, 367, **365**
 atresia, 367
 carcinoma, 367
 lacerations, 367
 coats, 369
 displacements, 368
 fundus, 364
 position, 368
 inversion, 368
 isthmus, 367
 ligament, broad, 371, **373**
 lateral, 120
 round, 372, **315**
 ligaments, 370
 action, 372
 false, 370
 anterior, 120
 true, 372
 lymphatics, 370
 masculinus, 352
 nerve supply, 370
 os, external, 367
 position, 368
 prolapse, 368
 retroflexion, 368
 retroversion, 368
 sections, **365**
 veins, 370
 wall, 369
 Uvula of Lieutaud, 346, **331**
 vesicæ, 346

V.

Vagina, 377
 atresia, 378
 azygos a., 330
 blood supply, 378
 lymphatics, 378
 mucous membrane, 377
 nerve supply, 378
 relations, 378
 sections, **365**
 wounds, 379
 Vaginal a., 330, **331, 373**
 plexus of n's, 357

Vaginal plexus of v's, 337
 Valsalva, sinus, 491
 sinuses, 457
 valve, **493**
 Valve, coronary, 484
 Eustachian, 484, 496, **490**
 ileo-cecal, 210, **211, 214, 215**
 ileo-colic, 210
 of foramen ovale, **490**
 of heart, 409
 bicuspid, 492
 mitral, 492
 of Heister, 238
 pyloric, 244
 Thebesian, 483, 484
 Valves of heart, semilunar, aortic,
 492, **493**
 pulmonary, 491
 tricuspid, 488, **485**
 Valvulæ conniventes, 200, **201**
 Varicocele, 89
 Varicose v., saphenous, 556
 Vas deferens, 353, **312, 349.**
 Vide Spermatic duct.
 artery of, 329, **322**
 diameter, 353
 division, funicular, 353
 inguinal, 353
 pelvic, 353
 testicular, 353
 Vasa brevia, 190, **188**
 of splenic, 226
 deferentia, 313
 intestini tenuis, 196, 278,
 194
 Vasti m's, 536
 Vastus externus m., 588, **561,**
 579, 583, 635
 insertion, 588
 nerve supply, 591
 origin, 588
 relations, 588
 internus m., 591, **561, 576,**
 579, 583
 insertion, 591
 nerve supply, 591
 origin, 591
 Vater, ampulla, 182, 243, 239,
 242
 Vein, appendicular, 196
 azygos, lower left, 523
 upper left, 524
 brachio-cephalic, 447
 bronchial, **475**
 cardiac, anterior, 483
 great, 483, **481, 490**
 posterior, 483, **481**
 circumflex iliac, deep, 284
 coronary, 186. *Vide* V., gas-
 tric.
 cystic, 186
 dorsal, of penis, 337
 epigastric, deep, 284
 superficial, 46, **44, 551**
 Eustachian, **485**
 femoral, 586, **44, 54, 57, 81,**
 322, 551, 557, 579
 common, **583**
 thrombosis, 586
 cutaneous, external, **557**
 internal, **557**
 deep, 586
 superficial, 586

Vein, gastric, 186, **223, 227, 271**
 gastro-epiploic, **223**
 left, 189, **188**
 right, 189, **188**
 hepatic, 234, 284, **254**
 iliac, circumflex, superficial,
 46, **44, 551**
 common, 284, 336
 external, 284, 336
 internal, 336
 ilio-lumbar, 337, **525**
 innominate, 447, **477**
 left, **481**
 right, **481**
 intercostal, 428, **465, 520,**
 521
 superior, 428, 429, **477**
 interventricular, posterior,
 483, **481**
 jugular, internal, **477**
 left, **481**
 right, **481**
 lumbar, 283
 ascending, **525**
 mammary, internal, 426,
 475, 477
 marginal, right, 484
 mesenteric, inferior, 199, 229,
 139, 148, 194, 198,
 223
 superior, 195, 229, **194,**
 223
 oblique, of Marshall, 449
 of Galen, 483, 484
 foramen, **485**
 of Marshall, 483
 oblique, 449
 ovarian, 283, **223, 227**
 pancreatico-duodenal, 185
 phrenic, 284
 plexus, hemorrhoidal, 337
 pampiniform, 89
 prostatic, 351
 Santorini, 385
 uterine, 337
 vaginal, 337
 vesical, 337
 vesico-prostatic, 337, 347
 popliteal, 652, **649, 673**
 portal, 186, **161, 183, 188,**
 223, 227, 231, 239
 radicles, 189
 relations, 186
 sinus, 189
 pudic, 337
 external, superficial, **44,**
 551
 internal, 642
 pulmonary, **465, 475, 481,**
 490, 510, 511
 left, **481, 485**
 relations, 507
 pyloric, 185
 renal, 283, **227, 267, 281**
 sacral, middle, 337
 saphenous, external or short,
 660, **661, 665**
 origin, 601
 internal or long, 556,
 660, **44, 54,**
 81, 551,
 557, 567,
 603, 661

- Vein, saphenous, internal or long, origin, 601
 sciatic, 642
 spermatic, 89, 285, **223, 227**
 splenic, 226, 229, **188, 191, 194, 198, 223, 239, 275**
 subclavian, **477, 481**
 left, **475**
 right, **481**
 subcostal, 429
 suprarenal, 269, 284, **227**
 thyroid, **481**
 tibial, posterior, 669
 transverse, 447
 umbilical, 496
 uterine, 370
 vertebral, **477**
- Veins, bronchial, 517
 femoral, 586
 of abdomen, superficial, 46
 of bladder, 347
 of foot, 547
 of heart, 483
 pulmonary, **485**
 of kidney, 262
 of leg, course, 547
 of pelvis, 336
 of portal system, 189
 of rectum, 339
 of stomach, 247
 of ureter, 262
 of uterus, 370
 saphenous, varicose, 556
- Vena azygos major, 448, 523, **465, 475, 477, 481, 525**
 relations, 523
 minor, 523, **516, 525**
 tertia, 524, **465, 525**
 cava, descending, 448
 inferior, 280, **161, 223, 281, 322, 477, 525**
 superior, 448, 449, **465, 475, 477, 481, 485**
 comes, of gastro-epiploic a., **183**
- Vena hemiazygos, 523
 accessoria, 524
 Venæ cordis minimæ, 484
 Venous arch, dorsal, of foot, **603**
 Ventricle, heart, 480
 of heart, 491, **490**
 dissection, 487
 infundibulum, 488
 left, **481**
 right, 488, **481**
 Ventricles of heart, **485**
 Vermiform appendix, 172, **154, 155, 211, 312. Vide Appendix, vermiform.**
 Vertebral ligament, 527
 common, 527
 anterior, 527
 vein, **477**
 Verumontanum, 352
 Vesical a., inferior, 329
 middle, 329, **322, 331**
 superior, 329, **322, 331**
 branch of obturator a., 330
 plexus of n's, 354, **355**
 sympathetic, **287**
 trigone, 346
 Vesicle, seminal, blood supply, 353
 function, 353
 nerve supply, 353
 Vesicles, seminal, 313, 352, **349**
 Vesico-prostatic plexus of v's, 337, 347
 Vesico-uterine ligaments, 371
 Vesicula prostatica, 352
 Vestibule, aortic, 492
 Sibson, 492
 Vestigial fold, Marshall, 473
 Villi of intestine, 205
 Viscera, abdominal, **133**
 diagram, **30, 31, 34, 35, 113**
 location, 27
 relations, 150
 of thoracic cavity, 436
 pelvic, 338
- Viscera, peritoneal covering, 130
 retroperitoneal, 130
 Visceral peritoneum, 116
 Volvulus, 179
- W.**
- Wall, abdominal, fascia, deep, 49
 limits, 22
 lymphatic glands, 393
 nerve supply, 103
 openings, 111
 pus, 72
 thickness, 41
 wounds, 104
 Wandering kidney, 255
 Weaver's bottom, 623
 White line, 318
 Winslow, foramen, 119, 129, **191, 245**
 hernia, 130
 ligament, 659, 709
 Wirsung, duct, 225
 Witzel's operation, 248
 Womb, 364. *Vide Uterus*, 364.
 Wounds of abdominal wall, 104
 of heart, 495
 of ileum, 140
 of intestine, small, 170
 of lungs, 508
 of vagina, 379
 Wrisberg, ganglion, **286, 453, 475**
 cardiac, 452
 Wyeth's amputation, 768
- X.**
- Xiphoid a., 426, **421**
 cartilage, **421**
- Z.**
- Zona orbicularis of Henle, 701



